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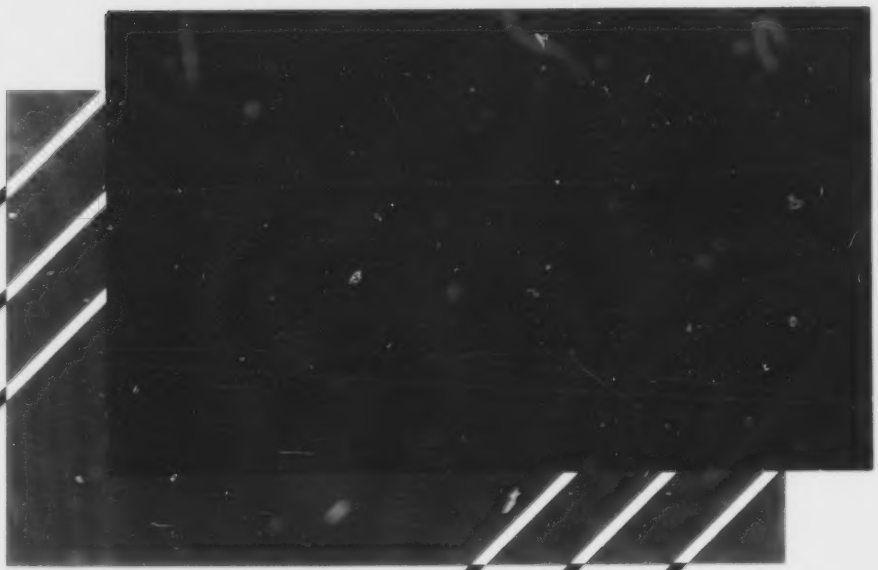

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TYPOLOGIES AND ECONOMIC ANALYSIS OF NEW INFORMATION TECHNOLOGIES: AVENUES OF RESEARCH

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FOREWORD

Since the early 1950s, specialists in the human and social sciences have drawn up a number of theoretical frameworks in order to take into account the society changes affecting the industrialized countries. Certain expressions were coined, such as R. Aron's "industrial society" (1961, 1966), M. McLuhan's "global village" (1964), K. Galbraith's "new industrial state" (1967), A. Gorz's "neo-capitalism" (1968), the "post-industrial society" described by A. Touraine (1971) and D. Bell (1973), M. U. Porat's "information economy" (1977), the "cabled society" of J. Martin (1978), the "telematics society" of S. Nora and A. Minc (1978), A. Toffler's "third wave" (1980), K. Valaskakis' neo-industrial society (1984), etc. Several studies were also conducted that dealt with more specific problems: lifestyles, the evolution of employment, industrial redeployment, communications, etc. Despite these conceptual efforts, there is still no universally accepted theoretical framework or tool for measuring the extent of the phenomenon our society is facing (Cordell, 1985, pp. 135-6).

We are of the opinion, however, that it is worthwhile establishing theoretical tools of analysis in order to place this phenomenon in a proper context and to estimate its economic and social effects. The consequences envisaged to date, notably by the Economic Council of Canada (1987), appear to be too significant for analysis to be ignored. The relevance of such an analysis is justified on the one hand by the need for authorities and decision-makers to refer to up-to-date information when establishing and adjusting policies. On the other hand, managers in the public and private sectors could also use such tools to justify decisions made in reaction to changes affecting environments both within and outside their organizations. This also applies to workers and their representatives, who have everything to gain from access to information that enables them to estimate and anticipate the consequences of change.

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INTRODUCTION

It is important to design tools for analysis when dealing with a phenomenon that appears to be by nature structural, ongoing, given to gradual development and historically unique. We feel this to be the case regarding the problem of new information technologies and their effect on the economic activity. This discussion paper will therefore focus on the search for new concepts, as well as analytical and forecasting tools related to these issues.

The first two chapters explore the literature in a search for approaches and typologies to use in analyzing the effect of new information technologies on economic activities. This overview of industrial and occupational typologies is exhaustive rather than comprehensive. We have opted for a detailed comparison of typologies that represent the various research trends, essentially those of the information economy and the computerized economy. This approach is extended in Chapter 3 with a critical analysis of the basis and limitations of selected approaches. Chapter 4 offers elements of a conceptual framework for the analysis of the phenomenon of electronic digitization and its economic impact.

This discussion paper is designed to encourage reflections on and to propose new dimensions for analyzing the social and economic impact of the new information technologies. A number of points obviously warrant further study and discussion.

1. INDUSTRIAL TYPOLOGIES OF INFORMATION/COMPUTERIZATION ACTIVITIES: SELECTIVE OVERVIEW OF THE LITERATURE

This chapter outlines various contributions specific to the study of the knowledge/information economy and the computerized economy, or research that is situated somewhere between these two major schools of thought. The final table in the Chapter, Table 25, compares a number of studies previously cited throughout the course of the text.

1.1 The Knowledge Industry and Information Industries and Sector(s)

1.1.1 Research based on the Works of Machlup: The Knowledge Industry

According to Lamberton (1984, p. 8), J.H. Knight was the first economist to recognize the importance of knowledge as a distinct economic product and activity. Knight (1921, pp. 260-1) noted that a number of organizations were devoted exclusively to knowledge activities, and that considerable sums of money and capital investment, both private and public, were allocated to knowledge activities. He also emphasized the existence of highly specialized industrial structures responsible for providing knowledge and guidance.

It was not until the early 1960s, however, that another economist, Fritz Machlup, further conceptualized the issue, establishing industrial and occupational typologies of knowledge activities.

Machlup (1962) defined the knowledge industry as "a group of establishments - firms, institutions, organizations and departments or teams within them, but also, in some instances, individuals and households - that produce knowledge, information service or information goods, either for their own use or for use by others."[1] On that basis, he included the activities presented in Table 1.

---

[1] MACHLUP (1980, p. 228).

Table 1

Machlup (1962): The Knowledge Industry

1 - Education:
- in the home
- on the job (apprenticeship and training)
- in the church
- in the armed forces
- in elementary and secondary schools
- in colleges and universities
- public libraries
- through teaching and private libraries
- in federal programs

2 - R & D:
- basic research
- applied research and development

3 - Media of Communication:
- printing and publishing
  . books and pamphlets
  . périodicals
  . newspaper
  . stationery and other office supplies
  . commercial printing and lithography
- photography and phonography
- stage and screen
  . theatres and concerts
  . spectator sports
- radio and television
  . manufacture of radio and television sets
  . repair of radio and television sets
  . radio and television production and distibution
- other forms of advertising
- telecommunications media
  . telephone (services)
  . telegraph (services)
  . postal services
- conventions and meetings

Table 1

Machlup (1962): The Knowledge Industry
(cont.)

4 - Information Machines:

- printing machinery
- musical instruments
- film machinery and equipment
- telephone and telegraph equipment
- measuring and controlling instruments
- signaling devices
- typewriters
- computers
- other office machines
- office machine parts

5 - Information Services:

- professional services
  - . legal
  - . engineering and architectural
  - . accounting and auditing
  - . medical care (except surgery)
- financial services
  - . bank branches
  - . security brokers
  - . commodity brokers
  - . insurance agents
  - . real estate agents
- wholesalers
- business services (various)
- government
  - . federal
  - . state and local

Machlup evaluated these industries at 29% of the U.S. GNP in 1958. In 1964, Gilbert Burck updated this information but, as Machlup himself pointed out[1], he provided very little information as for the methods of compilation used. The same applies to Jacob Marschak (1968), who calculated the share of the knowledge industries in 1968 at 40% of the U.S. GNP.

Machlup then embarked on an extensive program of research, the results of which were to have been published in 10 separate volumes:

Knowledge: Its Creation, Distribution and Economic Significance

Vol. 1 Knowledge and Knowledge Production
Vol. 2 The Branches of Learning
Vol. 3 The Economics of Information and Human Capital
Vol. 4 The Disciplines of Information
Vol. 5 Education
Vol. 6 The Creation of New Knowledge: Research and Art
Vol. 7 Media of Communication
Vol. 8 Information Services and Information Machines
Vol. 9 Knowledge Production: Its Size and Growth
Vol. 10 Knowledge Occupations and the Knowledgeable Society

The project was interrupted by his death in January 1983. The first three volumes were published in 1980, 1982 and 1984 respectively by Princeton University Press, while the preliminary version of the fourth volume was published by John Wiley and Sons in 1983[2]. Mary Huber, Machlup's research assistant, then joined forces with Michael Rubin and Elizabeth Taylor, synthesizing and updating the work for the period 1960-1980[3]. From 1958 to 1980, information industries grew from 29% to 34% of the U.S. GNP. This is far from the 50% predicted by Gilbert Burck in 1965 and by Peter Drucker in 1968[4].

---

1 MACHLUP (1980, p. xxvii).

2 MACHLUP, Fritz and Una MANSFIELD (1983).

3 RUBIN, Michael Rogers, Mary Taylor HUBER and Elizabeth Lloyd TAYLOR (1986)

4 BURCK, Gilbert and DRUCKER, Peter (1968, p. 263).

Rubin, Taylor and Huber faithfully respected Machlup's industry groupings, despite the modifications made since 1962 to the standard classification of statistical data and to sources of information[1]. These involve some activities added due to the technological evolution of the past two decades: cable television, mobile telephone and microwave equipment, communications satellites, satellite and missile-borne guidance systems, electronic navigation aids, computer facilities management, etc. (Table 2).

They deplored the fact that the Bureau of the Census classified photocopiers with photographic equipment rather than with office machines and equipment. They also doubted the relevance of including public libraries in the teaching category, rather than in the information services category, since they contribute to personal training. On that basis, why not also include museums, zoos, aquariums, planetariums and parks?

1.1.2 The Works of Oettinger and Shapiro (1975, 1980): Information Industries

In 1975, Anthony G. Oettinger and Peter D. Shapiro conducted their own study. Like Machlup, activity-related revenues or expenditures served as indicators. Unlike Machlup, however, their study employed an information industries concept. In addition, the groupings concentrated on a functional approach to the phenomenon: creators, processors, collectors, communicators and information equipment (Table 3).

Basically, Oettinger and Shapiro deleted approximately twenty of the industries presented by Machlup. The reduction can be explained by the effort to focus on statistical data from government sources. The education category is restricted to only public and private institutions, and no estimate appears under "authors, playwrights and poets". Of the six industries added, four were added because of the growth of these activities after Machlup's work in 1962: cable television, mobile radio, data bank information retrieval services and public opinion pollers (Table 4).

---

[1] For example, title abstractors offices are now included in the professional services group.

Table 2

Rubin, Huber et Taylor (1986): The Knowledge Industry

1 - Education:
- in the home
- pre-school
- elementary and secondary schools
- colleges and universities
- in the church
- in the armed forces
- commercial schools
- federal programs
- public libraries
- apprenticeship and job training*

2 - R & D:
- basic research
- applied research
- development

3 - Media of Communication:
- printing and publishing
  . books and brochures
  . périodicals
  . newspapers
  . commercial printing and lithography
  . stationery and office supplies (greeting cards, binders, note pads, pencils, pens, stencils, carbon paper, ribbon, printer and typewriter ribbon, etc.)
- photography and phonography (including photocopiers)
- stage and screen (film production and distribution, plays, concerts and spectator sports)
- radio and television (broadcasting)
- cable television**
- advertising
- telephone, telegraph, postal services
- conventions and meetings

---

* Not estimated by Rubin, Huber and Taylor due to the quality of the available data and the problem of double counting for this activity, the expenses or costs of which are entered under commercial education, media of communication (books and volumes, conventions), professional services (management consultants), and under information machines (computers and other related equipment).

** An addition, compared to Machlup's typology.

Table 2

Rubin, Huber et Taylor (1986): The Knowledge Industry
(cont.)

4 - Information Machines:

- machinery used in communication industries
  - . photographic equipment
  - . radio and television sets
  - . phonographs
  - . broadcasting equipment (radio and television)
  - . printing machinery and equipment
  - . telephone and telegraph equipment
  - . film machinery and equipment
  - . mobile telephone and microwave equipment*
  - . communications satellites*
  - . postal equipment
  - . microphones (for conventions)
- manufacture of measuring and controlling instruments
  - . scales and balances
  - . electrical measuring instruments
  - . electrical control apparatus
  - . scientific and professional instruments
  - . electronic navigation aids*
  - . radar, sonar and other search and detection apparatus*
  - . satellite and missile-borne guidance systems*
  - . mechanical measuring instruments
  - . optical instruments and lenses
  - . watches, clocks (and parts)
- signaling devices
- computers and other office equipment
  - . computers
  - . adding and calculating machines
  - . typewriters
  - . other office machines

---

* An addition, compared to Machlup's typology.

Table 2

Rubin, Huber et Taylor (1986): The knowledge Industry (cont.)

5 - Information Services:

- Professional Services
  - . legal
  - . engineering and architectural
  - . accounting and auditing
  - . medical services (diagnosis and consultation only)
- Financial Services
  - . bank branches
  - . security brokers
  - . commodity brokers
  - . insurance
  - . real estate
- wholesalers (agents and brokers)
- computer services
  - . programming and software services
  - . data processing services
  - . computer facilities management*
  - . other related services*
- various business services
  - . management consultants and public relations agencies
  - . debt collection services
  - . copy and photocopying services
  - . employment agencies
  - . investigative agencies
  - . interior decorating services
  - . title abstractors offices*
  - . secretarial services
  - . auction services

---

* An addition, compared to Machlup's typology.

Table 2

Rubin, Huber et Taylor (1986): The Knowledge Industry
(cont.)

5 - Information Services: (cont.)

- government (federal, state and local)
  - international affairs (conduct of foreign affairs, information and exchange services)
  - natural resources (analysis and identification of natural resources, administration)
  - commerce (regulation of commerce and finance)
  - general government: legislative and judicial functions, executive direction and management, financial management (federal), property records management, civilian weather services, protection services, etc.

---

* An addition, compared to Machlup's typology.

Table 3

Oettinger and Shapiro (1975): Information Industries

1 - Creators:	- research and development - advertising - computer programming services - authors, playwrights and poets
2 - Processors:	- data processing services - social security administration - legal services - banking and credit card services - insurance agents - securities brokers
3 - Collectors:	- libraries - intelligence community - data bank information retrieval services - public opinion pollers
4 - Communicators:	- education - telephone and telegraph - postal services - mobile radio - radio and television - cable television - newspapers and periodicals - theatres - motion pictures - book publishing - agriculture change agents
5 - Information Equipment Producers:	- computers and related equipment - radio and television sets - paper - photographic equipment and supplies

Table 4

Major Differences between the Industry Groupings
of Machlup and Oettinger-Shapiro

1- Industries Deleted, compared to Machlup's Typology:

- education in the home, in the church, in the armed forces and job apprenticeship
- photograph and phonograph services
- concerts and spectator sports
- conventions and meetings
- professional services: engineering and architectural, accounting and auditing, medical care (non-surgical)
- business services (various)
- federal, state and local government, except for services related to social assistance and intelligence community services
- wholesalers
- musical instruments
- telephone and telegraph equipment
- measuring and controlling instruments
- signaling devices
- printing machinery
- repair of radio and television sets
- commercial printing and lithography
- office supplies (except paper)

2- Industries Added, compared to Machlup's Typology:

- agricultural change agents
- authors, playwrights and poets
- mobile radio
- cable television
- public opinion pollers
- data bank information retrieval services

In 1980, Oettinger published a new version of his work. In comparison with the previous typology, four industries were added:

- arenas and organized sport
- business consulting services
- components and electronic accessories
- satellites.

The first two are close to Machlup's, while the latter two were added due to the growth of these industries.

1.1.3 Daniel Bell: The Information Economy in a Post-Industrial Society

Daniel Bell's work schematizes the appearance of what he terms the post-industrial society. This ideal type is characterized by the substitution of the production of goods with information or knowledge, which has meant that specialized workers, manual labourers, sales and office personnel have gradually been superseded by scientists, professionals and technicians. For him, the information economy thus constitutes an important part of the post-industrial society. He relies basically on the statistical work of Machlup to support his thesis. This does not prevent him, however, from presenting two typologies on the matter. The first dates from 1973 and can be described as a typology of the post-industrial society. The second dates from 1979 and focuses on the information economy[1]. No estimates were provided, however, for either typology.

As shown in Table 5, the proposed typologies substantially reduce the number of industries used by Machlup. In the first case, the knowledge sector was confined exclusively to research and development, education, medicine and administration. His second typology was more extensive. Libraries and other professional services were added (lawyers, accountants, etc.). These knowledge industries, moreover, are included in an information sector that includes entertainment, economic recording and transaction services and a service infrastructure.

---

[1] See BELL (1981).

Table 5

The Industrial Typologies Proposed by Daniel Bell (1973, 1979)

1) The Post-industrial Society (1973)

- primary:	. agriculture . fishing . mining . forestry
- secondary:	. manufacturing . construction
- tertiary: (blue collar)	. transportation . storage . public utilities . repair services . leisure . laundry and other personal services
- quartenary: (white collar)	. finance . insurance . real estate . commerce
- quinary: (knowledge industries)	. research . education . health . administration

2) The Information Economy (1979)

- knowledge industries:	. R & D . education . libraries . professional services that apply knowledge (lawyers, doctors, accountants, etc.)
- entertainment industries:	. motion picture . television . music
- economic recording and transaction industries:	. banks . insurance . brokerage
- service infrastructure:	. telecommunications . computers and software . etc.

1.1.4 Research based on Porat and the OECD: Information Industries and Sectors

a) Porat and associates (1974-1977)

In 1974, Edwin Parker and Marc Uri Porat presented a typology of the information sectors and information industries. Porat then further developed the idea in his doctoral thesis at Stanford University in 1976. In 1977, he published nine volumes for the U.S. Department of Commerce outlining his approach, assisted by Michael Rubin[1]. This major work outlined the activities related to the production and distribution of information. The figures put forth by Porat far surpassed those obtained by followers of Machlup's approach. The figures reveal that information activities generated 46% of the U.S. GNP in 1967[2], accounted for 53% of salaries and wages and employed almost 50% of the labour force.

Porat and Rubin subdivided the economy into six sectors of activity. The first, which they baptized the primary information sector, is composed of all industries that produce information goods and services sold on the market (see Table 6). This sector includes various producers, from computer manufacturing to education, printing, advertising and insurance. Eight distinct classifications are identified:

- knowledge production and inventive industries;
- information distribution and communication industries;
- risk management industries;
- search and co-ordination industries information processing and transmission services (electronic and non-electronic);
- information goods manufacturing industries;
- certain government activities that are similar to services on the market (e.g.: postal services and education);
- support facilities (e.g.: real estate, offices and schools).

The secondary information sector consists of two parts: private bureaucracy and government bureaucracy. It includes all the planning, co-ordination, regulation and evaluation activities of the various levels of government, as well as all information

---

[1] PORAT, Marc Uri and Michael RUBIN (1977).

[2] Including 21.1% for the secondary information sector.

services produced and consumed in-house by private firms. This sector therefore includes all non-market information activities except of course some government domains listed earlier under the primary information sector (education, postal service).

The productive sector concerns all organizations involved in the production and distribution of non-information goods. Here again a distinction is made between a private component and a government component. This sector is the heart of the traditional economy with agricultural, mining and forestry industries and most construction, transportation and manufacturing industries.

Lastly, the household sector provides manpower to both information sectors (primary and secondary) and to non-information sectors (private and government productive sectors). It constitutes final demand for the goods and services sold by the primary information sector and the private productive sector.

Table 7 outlines the major differences between Machlup and Porat. As regards education, the Porat-Rubin (1977) study sticks exclusively to what is statistically covered by national accounting, while on-the-job training and education in the church, the home and the armed forces are excluded. As regards the media of communications, the activities studied are compatible. Machlup ignores, however, retail trade because of its excessively large proportion of manual labour. By focusing on national accounting, Porat and Rubin ignore conventions and meetings. If there are substantial disparities in the information machines category, there is nonetheless a consensus regarding measuring and controlling instruments, office machines, computers, printing equipment, and telegraph and telephone equipment. Machlup added musical instruments, while the Porat-Rubin study (1977) was interested in a number of intermediate goods, including semiconductors and electronic tubes, which were not mass produced in 1958. Nevertheless, when Machlup focused on final demand, he considered this input in the cost of information machines, thus avoiding double counting. The interest of the Porat-Rubin study (1977) in value added led the authors to include industries not found in Machlup's typology: ink, electronic components, various electronic equipment and paper industries machinery. Information services are relatively identical, although Machlup was also interested in concerts and spectator sports[1]. As regards the research and

[1] Porat includes ticket agencies and theatrical producers (7922), but not artists, musicians and others working outside radio and television stations (7929).

Table 6

Porat (1977): The Primary Information Sector*

I - MARKETS FOR INFORMATION

1. KNOWLEDGE PRODUCTION AND INVENTIVE INDUSTRIES

A) R & D and Inventive Industries

(7391) Commercial Research and Development Laboratories
(7397) Commercial Testing Laboratories
(8922) Non-Profit Education and Scientific Research Agencies

B) Private Information Services

(6281) Serv. Allied with the Exchange of Secur. or Commodities
(6511) Combinations of Real Estate, Ins., Loans, Law Offices
(7392) Business, Mngt., Administrative & Consulting Services
(8111) Legal Services
(8911) Engineering and Architectural Services
(8931) Accounting, Auditing, and Bookkeeping Services
(8999) Services, Not Elsewhere Classified

2. INFORMATION DISTRIBUTION AND COMMUNICATION INDUSTRIES

A) Education

(8211) Elementary and Secondary Schools
(8221) Colleges, Universities and Professional Schools
(8222) Junior Colleges and Technical Institutes
(8241) Correspondence Schools
(8243) Vocational Schools, Except Vocational High Schools
(8299) Schools and Educ. Services, Not Elsewhere Classified

B) Public Information Services

(8231) Libraries and Informations Centers

C) Regulated Communication Media

(4832) Radio Broadcasting
(4833) Television Broadcasting

D) Unregulated Communication Media

(2711) Newspapers: Publishing, Publishing and Printing
(2721) Periodicals: Publishing, Publishing and Printing
(2732) Books: Publishing, Publishing and Printing
(2741) Miscellaneous Publishing
(7351) News Syndicates
(7813) Motion Picture Production, Except for Television
(7814) Motion Picture and Tape Production for Television
(7815) Production of Still and Slide Films
(7816) Motion Picture Film Exchange
(7817) Film or Tape Distribution for Television
(7821) Motion Picture Service Industries
(7922) Theatrical Producers (Except Motion Pictures and Miscellaneous Theatrical Services)

Table 6

Porat (1977): The Primary Information Sector
(cont.)

II - INFORMATION MARKETS

3. SEARCH AND COORDINATION INDUSTRIES

A) Search and Non-Speculative Brokerage Industries

(6052) Foreign Exchange Establishments
(6053) Check Cashing Agencies and Currency Exchanges
(6055) Clearing House Associations
(6161) Loan Correspondents and Brokers
(6231) Security and Commodity Exchange
(6411) Insurance Agents, Brokers and Services
(6531) Agents, Brokers and Managers
(6541) Title Abstract Companies
(7313) Radio, Television, and Publishers' Advertising Representatives
(7321) Consumer Credit Reporting Agencies, Mercantile Reporting Agencies and Adjustments and Collection Agencies
(7361) Private Employment Agencies
(7398) Temporary Help Supply Services
(7818) Services Allied to Motion Picture Distribution

B) Advertising Industries

(3993) Signs and Advertising Displays
(7311) Advertising Agencies
(7312) Outdoor Advertising Services
(7319) Miscellaneous Advertising
(7331) Direct Mail Advertising Agencies

C) Non-Market Coordination Institutions

(8611) Business Associations
(8621) Professional Membership Organisations
(8631) Labor Unions and Similar Labour Organizations
(8651) Political Organizations

4. RISK MANAGEMENT INDUSTRIES

A) Insurance Industries (Components Only)

(63) Life, Accident, Fire and Casualty
(636) Title Insurance

B) Finance Industries (Components Only)

(60) Commercial, Savings Banks & Related Institutions
(61) Credit Institutions

C) Speculative Brokers (Components Only)

(62) Security Brokers, Commodity Contractors
(6794) Patent Owners and Lessors

Table 6

Porat (1977): The Primary Information Sector
(cont.)

III - INFORMATION INFRASTRUCTURE

5. INFORMATION PROCESSING AND TRANSMISSION SERVICES

A) Non-Electronic Base Processing

Fixed Costs:
(2753) Engraving and Plate Printing
(2791) Typesetting
(2793) Photoengraving
(2794) Electrotyping and Stereotyping

Variable costs:
(2732) Book Printing
(2751) Commercial Printing, Except Lithographic
(2752) Commercial Printing, Lithographic
(2799) Bookbinding and Related Work
(7221) Photographic Studios, Incl. Commercial Photography
(7332) Blueprinting and Photocopying Services
(7359) Stenographic Services, and Duplicatiog Services Not Elsewhere Classified
(7395) Photofinishing Laboratories

B) Electronic Based Processing

(7370) Pure Data Processing Services

C) Telecommunication Infrastructure

(4811) Telephone Communication (Wire or Radio)
(4821) Telegraph Communication (Wire or Radio)
(4899) Communication Services, Not Elsewhere Classified

6. INFORMATION GOODS MANUFACTURING INDUSTRIES

A) Non-Electronic Consumption or Intermediate Goods

(2621) Paper Mills, Except Building Paper Mills
(2642) Envelopes
(2761) Manifold Business Forms
(2782) Blankbooks, Loose Leaf Binders and Devices
(2893) Printing Ink
(2895) Carbon Black
(3861) Photographic Equipment and Supplies
(3951) Pens, Pens Points, Fountain Pens, Ball Point Pens, Mechanical Pencils and Parts
(3952) Lead Pencils, Crayons, and Artists' Material
(3953) Marking Devices
(3955) Carbon Paper and Ink Ribbons

B) Non-Electronic Investment Goods

(3554) Paper Industries Machinery
(3555) Printing Trades Machinery and Equipment
(3574) Calculating & Accounging Machines, Except Electronic Computing Equipment
(3576) Scales and Balances, Except Laboratory
(3579) Office Machines, Not Elsewhere Classified

Table 6
Porat (1977): The Primary Information Sector
(cont.)

(384) Mechanical Measuring and Controlling Instruments Except (3822) and (3825)
(3822) Automatic Temperature Controls
(3831) Optical Instruments and Lenses

C) Electronic Consumption or Intermediate Goods

(3652) Phonograph Records
(3671) Radio & Television Receiving Electron Type Tube Except Cathode Ray
(3672) Cathode Ray Picture Tubes
(3673) Transmitting, Industrial and Special Purpose Electron Tubes
(3674) Semiconductors and Related Devices
(3679) Electronic Components and Accessories, Not Elsewhere Classified
(5065) Electronic Parts and Equipment —

D) Electronic Investment Goods

(3573) Electronic Computing Equipment
(3825) Electric Measuring Instruments and Test Equipment
(3651) Radio and Television Receiving Sets (Except Communication Types)
(3661) Telephone and Telegraph Apparatus
(3662) Radio & Television Transmitting, Signalling and Detection Equipment and Apparatus
(3693) Radiographic X-Ray, Fluoroscopic X-Ray, Therapeutic X-Ray, and Other X-Ray Apparatus and Tubes; Electromedical and Electrotherapeutic Apparatus
(3811) Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment

IV - WHOLESALE AND RETAIL TRADE IN INFORMATION GOODS

7. HOUSEHOLD INVESTMENT GOODS

(5732) Radio and Television Stores
(5996) Camera, Photographic Supply Stores, Hand Calculators

8. CONSUMPTION GOODS

(5942) Book Stores
(5994) News Dealers and Newstands
(7832) Motion Picture Theaters, Except Drive-in
(7833) Drive-in Motion Picture Theaters

V - SUPPORT FACILITIES FOR INFORMATIONAL ACTIVITIES

(15) Contract Construction of Office, Schools, Communication Buildings
(65) Rentals of Information Structures
(25) Furnishings for Office Buildings

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* Porat presented this list as a detailed typology. A certain number of activities are not included such as postal services, typewriter manufacturing and medical services.

Source: PORAT, M.U. and RUBIN, M. (1977, volume 1, p. 28).

Table 7

Comparison of the Industrial Typologies of Machlup and Porat-Rubin

INDUSTRY BRANCHES	MACHLUP	PORAT-RUBIN
EDUCATION		
Education in the Home	x	
Training on the Job	x	
Education in the Church	x	
Education in the Armed Services	x	
Elementary and Secondary Education	x	x
Higher Education	x	x
Commercial Schools	x	x
Federal Expenditures	x	x
Public Libraries	x	x
Implicit Cost of Education		
Students' Foregone Earnings	x	
Implicit Rents of Buildings	x	
MEDIA OF COMMUNICATIONS		
Printing and Publishing	x	x
Photography and Phonography	x	x
Stage Podium and Screen	x	x
Radio and Television	x	x
Other Advertising	x	x
Telecommunications	x	x
Conventions and Meetings	x	
INFORMATION MACHINES		
Printing Trades Machinery	x	x
Paper Industries Machinery		x
Musical Instruments	x	
Motion Picture Equipment	x	x
Telephone and Telegraph Equipment	x	x
Signaling Services	x	x
Measuring and Controlling Instruments	x	x
Typewriters	x	x
Computers	x	x
Office Machines and Parts	x	x
Semiconductors*		x
Electronic Tubes*		x
Other Electronic Equipment		x
Ink		x
Photographic Equipment and Supplies	x	x
INFORMATION SERVICES		
Legal	x	x
Engineering and Architectural	x	x
Accounting and Auditing	x	x
Medical	x	x
Securities Brokers	x	x
Insurance Agents	x	x
Real Estate Agents	x	x
Wholesale Agents	x	x
Retail "Information" Stores		x
Government Activities	x	x
OTHER INFORMATION ACTIVITIES		
Research and Development	x	x
Construction of Information Buildings		x
Nonprofit Activities	x	x

* Not yet in mass production in 1958, but included in any case by Machlup as part of the cost of other information machines. As noted in the text, where a product is only an input for another industry branch, Machlup included its cost in the output of that branch.

SOURCE: Rubin, Huber et Taylor (1986, p. 8-9).

development, Machlup presented the elements separately, while Porat-Rubin presented them collectively. Support facilities compiled by Porat-Rubin include office supplies, construction, school rental and maintenance, libraries and office buildings. Machlup only included expenditures related to schools, libraries and churches, which he lists under "education".

In short, the Porat-Rubin industrial typology differed from Machlup's typology in that it added the paper industry and paper industry machinery, electronic equipment and components, ink, retail trade in information goods, and the rental, construction and furnishing of office buildings. However, it excluded on-the-job training, education in the home, the church and the armed services, conventions, musical instruments, concerts and spectator sports.

The major differences involved on one hand the choice of the estimate used (value added vs product cost), and, on the other hand, technological innovations that made their appearance after Machlup's study. In the latter case, however, these can be included in Machlup's classification of activities, as Rubin, Huber and Taylor (1986) pointed out.

Another of Porat's contributions was the definition of a secondary information sector that allowed for the evaluation of in-house production and consumption of goods and services, an analysis that preceding typologies did not allow for. This was made possible by using an occupational typology that will be studied in Chapter 2.

b) The OECD (1981, 1986)

In 1977, the OECD called on Porat's services. He drew up a national accounting manual of information activities that allowed for international comparisons. The organization used the manual in drawing up its own typology. The 1981 study evaluated the primary information sector for Japan (1960, 1965, 1970), Sweden (1970 and 1975), the United Kingdom (1963 and 1972), the United States (1958, 1967, 1972), France (1962, 1968, 1973) and Australia (1968-1969). A secondary information sector was quantified for Japan (1965, 1970), the United Kingdom (1963, 1972) and the United States (1958, 1967, 1974).

The OECD conducted another study in 1986 that focused exclusively on the primary information sector. New estimates were made for Belgium (1975, 1983), Australia (1978), West Germany (1970, 1980), Norway (1975, 1980), Sweden (1980) and the United Kingdom (1980).

The results indicate the disparities in the growth of the information sector in each country. In the 1970s, for example, the primary information sector represented between 17% and 25% of GDP for the countries studied. The secondary information sector was 11% (1972) in the U.K., compared to 24.4% (1974) in the U.S.

Table 8 presents the definition of the primary information sector used in these two studies. Table 9 compares the OECD approach for this sector with that of Porat-Rubin. While the major categories remain similar, there are differences in the details of others.

The OECD included at the outset an entire series of activities ignored by Porat-Rubin (1977): inspection, testing, grading and exploration activities related to agriculture, fishing, mining and energy, as well as textiles, transportation and tourism. Additions in the manufacturing category included farm grading machinery, gravure presses and lithographic platemaking.

In the tertiary sector, a number of differences between the two typologies are due to the fact that the OECD included in their entirety industrial codes favoured chosen more selectively by Porat and Rubin. "Artistic activities" (authors, artists, writers, sculptors and entertainers) were all taken into account by the OECD, whereas Porat and Rubin focused exclusively on activities involving radio and television, and theatrical ticketing and promotion services. All financial services were included in the OECD classification. Some banking and credit industries, and security and commodity brokers, followed the Porat and Rubin definition. The same applies to professional services. Porat and Rubin used only 60% of code 73 (U.S. SIC codes), neglecting protection services for example, while the OECD included all of code 8329 (ISIC). Porat and Rubin did not cover all types of repairs and excluded watch and clock repair services. Private secretarial and collection services were a new addition for the Porat and Rubin study, as were business, professional, union, religious and political associations.

Generally speaking, the OECD studies significantly increased the number of industrial activities included in the Porat and Rubin primary information sector. The estimates excluded, however, the following:

Category III - Wholesale and Retail Trade in Information Goods,
Category IV - Auxiliary Information Services and Equipment.

Table 8

OCDE (1981, 1986): The Primary Information Sector*

I INFORMATION PROCESSING SERVICES

1. Branches Specialized in Knowledge Creation

a) Research, Development and Study Services

- Product inspection services (agriculture, mining, textile, transportation, tourism) (1120, 1302, 2100, 3211, 7191a)
- Exploration services (mining and energy) (2200)
- Research and scientific institutes (9320)

b) Private Information Services

- Legal services (8321)
- Accounting, auditing and bookkeeping services (8322)
- Engineering, architectural and technical services (8324)
- Business services not elsewhere classified (8329)
- Medical and dental services (9331)

2. Branches Specialized in Research, Co-ordination and Risk Management

- Office services and railroad clearing houses (7111)
- Flying control centre operations (7132)
- Tourist and travel agencies (7191b)
- Brokerage services (8102, 8200)
- Advertising services (8325)
- Credit institutions (8101, 8102, 8103)

3. Branches Specialized in Distributing and Communicating Information

- Education (9310)
- Libraries, museums and related institutions (9420)
- Radio and television broadcasting (9413)
- Motion picturel production and distribution (9411,9412)
- Theatrical production services (9414)
- Authors, composers and related artists (9415)
- Photographic studios (9592)

4. Branches Specialized in Processing and Transmitting Information

- Printing, publishing and allied industries (3420)
- Communication services (7200)
- Data processing services (8323)

* The codes in parentheses are from the United Nations ISIC Series M: n° 4, Revision 2, add. 1 (1971).

Table 8

OCDE (1981, 1986): The Primary Information Sector
(cont.)

II INFORMATION GOODS

1. Consumer Goods or Non-Electronic Intermediate Goods

- Pocket books (3233)
- Rulers (3319)
- Stationery, etc. (3411)
- Office supplies (3412, 3419)
- Inks, etc. (3529)
- Photographic and optical goods (3839, 3852)
- Watches and clocks (3853)
- Pens, pencils, etc. (3909)

2. Non-electronic Equipment

- Machinists' precision tools (3811)
- Printing machinery and equipment (3819, 3824)
- Measuring and controlling equipment (parts) (3822, 3851)
- Office machines (parts) (3825)
- Optical instruments and lenses (3620)

3. Consumer Goods, Intermediate Goods and Electronic Equipment

- Office machines (electronic parts) (3825)
- Electronic measuring and controlling equipment (parts) (3831, 3851)
- Radio, television and telecommunications equipment, etc. (3862)

III WHOLESALE AND RETAIL TRADE IN INFORMATION GOODS

- Wholesale trade (6100)
- Retail trade (6200)

IV AUXILIARY INFORMATION SERVICES AND EQUIPMENT

- Schools and office furniture (3520, 3560, 3812)
- Contract construction of office, school and communications buildings (including repairs and maintenance done on an irregular basis by full-time personnel) (5000)
- Leasing of real estate of "informational" types (8310)
- Business machine rentals (8330)
- Repair of information equipment (9512, 9514, 9519)

Source: OECD (1981, volume II, pp. 29-31).

Table 9

Comparison of the Industrial Typologies
of the OECD and Porat-Rubin*

1) Codes included by the OECD and excluded by Porat-Rubin

1120	Contract inspection, testing and grading of agricultural agricoles effectués à contrat, services d'enregistrement products, record services
1302	Fishery inspection services
2100	Textile grading services/factories
2200	Pocket book manufacture
3822	Agricultural grading machinery and equipment
7111	Railroad clearing houses
7132	Flying control centre operations, radar station operations
7191	Inspection/sampling services connected with transportation; tourist and travel agencies
8329	Some business services, including protection services
8101	Some financial services
8102	Some financial services
8103	Some financial services
9514	Some including watch and clock repair
2754	Commercial printing and engraving
2795	Lithographic platemaking

2) Codes excluded by OECD and included by Porat-Rubin

9350	Business, professional, union, religious and political associations (except civil and social organizations)

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* The codes are from the United Nations ISIC Series M: No. 4, revision 2, Add. 1, 1971.

This decision was made due to difficulties regarding statistical data[1].

As is the case with Porat-Rubin, a secondary information sector was analyzed. For further details on the occupational typology employed, refer to Chapter 2.

c) Rubin and Taylor (1981)

In 1981, Michael Rubin updated his 1977 study done with Porat for the U.S. Department of Commerce[2]. He worked in conjunction with Elizabeth L. Taylor, with whom, as mentioned earlier, he would later put the finishing touches to Machlup's posthumous work. The primary information sector was estimated to be 24.8% of the GNP in 1972, compared to 25.1% in 1967, as determined by Porat-Rubin. No estimate was made for the secondary information sector.

For several industrial codes, Rubin and Taylor did not differentiate precisely between information activities and non-information activities (Table 10). This explains why comparisons between the Porat and Rubin typology and the OECD typology, presented in Tables 11 and 12, are difficult to make. Entertainment and recreational services and wholesale and retail trade are good examples. However, the codes selected hold no real surprises at this level of disaggregation, given the similarity of approach.

In many respects, the Rubin and Taylor typology is quite different from the Porat and Rubin typology. Deletions included manufacturers of ink and carbon paper, and maintenance and repair on information buildings, the former due to their low statistical importance and the latter because it exceeded the authors' definition of the information sector. As a general rule, however, the changes bring the typology closer to the choices of Porat and the OECD. In fact, the Rubin and Taylor typology introduced an overall grouping of mining services, leasing services and equipment repair not included in the Porat and Rubin typology but well noted in the OECD typology. Table 11 shows that Rubin and Taylor, however, favoured cultural organizations such as museums, art

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[1] In the 1981 study, Stuart Wall estimated the average share of these omitted categories at 2.8% of GNP. (OECD 1981, vol. II, p. 32).

[2] RUBIN, Michael Rogers and Elizabeth TAYLOR (1981).

Table 10

The Industrial Typology of Rubin-Taylor (1981)

	BEA Codes[1]	INFORMATION INDUSTRIES	U.S. SIC Codes 1970
1.	Information Buildings		
	11.0202	New Office Buildings	pt. 15, pt. 17
	11.0207	New Educational Buildings	pt. 15, pt. 17
	11.0301	New Telephone & Telegraph Facilities	pt. 16, pt. 17
	11.0504	New Oil & Gas Exploration	pt. 108* pt. 1112* pt. 1213* pt. 138* pt. 148*
2.	Office Furniture		
	23.0100	Wood Office Furniture	2521
	23.0200	Metal Office Furniture	2522
	23.0300 (pt.)	Public Building Furniture	pt. 2531*
3.	Paper		
	24.0200 (pt.)	Paper Mills	pt. 262*
	24.0400	Envelopes	2642*
	24.0701 (pt.)	Paper Coating & Glazing	pt. 2641*
4.	Printing and Publishing		
	26.0100	Newspapers	271
	26.0200	Periodicals	272
	26.0301	Book Publishing	2731
	26.0302	Book Printing	2732
	26.0400 (pt.)	Miscellaneous Publishing	pt. 274*
	26.0501 (pt.)	Commercial Printing	pt. 2751-2*, 2754*
	26.0502 (pt.)	Lithographic Platemaking & Services	pt. 2795*
	26.0601	Manifold Business Forms	276
	26.0602	Blankbooks & Looseleaf Binders	2782
	26.0700	Greeting Card Publishing	277
	26.0801	Engraving & Plate Printing	2753
	26.0802	Bookbinding & Related Work	2789
	26.0803	Typesetting	2791
	26.0804	Photoengraving	2793
	26.0805	Electrotyping & Stereotyping	2794
5.	Printing & Paper Machinery		
	48.0400 (pt.)	Paper Industries Machinery	pt. 3554
	48.0500	Printing Trades Machinery	3555
6.	Office, Computing & Accounting Machines		
	51.0101	Electronic Computing Equipment	3573
	51.0102	Calculating & Accounting Machines	3574
	51.0200	Typewriters	3572
	51.0200	Scales & Balances	3576
	51.0400	Office Machines, n.e.c.	3579

[1] Bureau of Economic Analysis Industrial Codes (U.S. Dept. of Commerce).

* Codes that contain both information and non-information activities.

Table 10
The Industrial Typology of Rubin-Taylor (1981)
(cont.)

	BEA Codes[1]	INFORMATION INDUSTRIES	U.S. SIC Codes 1970
7.	Electronic Measuring Instruments		
	53.0100	Instruments to Measure Electricity	3825
8.	Radio, TV, & Communication Equipment		
	56.0100	Radio & TV Receiving Sets	3651
	56.0200	Phonograph Records & Tape	3652
	56.0300	Telephone & Telegraph Apparatus	3661
	56.0400	Radio & TV Communication Equip.	3662
9.	Electronic Components		
	57.0100	Electron Tubes	3671-3
	57.0200	Semiconductors & Related Devices	3674
	57.0300	Electronic Components, n.e.c.	3675-9
10.	Miscellaneous Electronic Instruments		
	58.0300	X-ray Apparatus & Tubes	3693
11.	Mechanical Instruments		
	62.0100	Engineering & Scientific Inst.	3811
	62.0200	Mechanical Measuring Devices	3823-4, 3829
	62.0300	Automatic temperature controls	3822
	62.0700	Watches, Clocks & Parts	387
12.	Photographic Equipment		
	63.0100	Optical Instruments & Lenses	383
	63.0300	Photographic Equip. & Supplies	386
13.	Advertising Signs		
	64.0501	Pens & Mechanical Pencils	3951
	64.0502	Lead Pencils & Art Goods	3952
	64.0503	Marking Devices	3953
	64.0504	Carbon Paper & Inked Ribbons	3955
	64.1100	Signs & Advertising Displays	3993
14.	Communications, Except Radio & TV		
	66.0000	Communications, Except Radio & TV	48 (excl. 483)
15.	Radio & TV Broadcasting		
	67.0000	Radio & TV Broadcasting	483
16.	Information Trade Margins		
	69.0100 (pt.)	Wholesale Trade*	
	69.0200 (pt.)	Retail Trade*	

[1] Bureau of Economic Analysis Industrial Codes (U.S. Dept of Commerce).

* Codes that contain both information and non-information activities.

Table 10

The Industrial Typology of Rubin-Taylor (1981)
(cont.)

	BEA Codes[1]	INFORMATION INDUSTRIES	U.S. SIC Codes 1970
17.	Finance & Insurance		
	70.0100	Banking	60
	70.0200	Credit Agencies	61 (excl. pt. 613) 67
	70.0300 (pt.)	Security & Commodity Brokers	62*
	70.0400	Insurance Carriers	63
	70.0500	Insurance Agents & Brokers	64
18.	Real Estate		
	71.0200 (pt.)	Real Estate	65-6*, pt. 1531*
19.	Repair of Information Products		
	72.0200	Personal & Repair Services	72 (excl. 723-4, 762-4, pt. 7699)*
20.	Miscellaneous Business Information Services		
	73.0100 (pt.)	Miscellaneous business Services	732-9 (excl. 7396)*, 7692*, 7694*, pt7699*
	73.0200	Advertising	731*
	73.0300	Miscellaneous Professional Ser.	81, 89 (excl. 8922)
21.	Motion Pictures		
	76.0100	Motion Pictures	78
	76.0200 (pt.)	Amusements & Recreation Services	79*
22.	Medical & Educational Services		
	77.0100 (pt.)	Doctors & Dentists	801-3*, 8041*
	77.0200 (pt.)	Hospitals	806*
	77.0400	Educational Services	82
	77.0500 (pt.)	Nonprofit Organizations	84*, 86*, 8922*
23.	Postal Services		
	78.0100 (pt.)	U.S. Postal Services State, Local	4311*
24.	Federal Government Information Workers		

[1] Bureau of Economic Analysis Industrial Codes (U.S. Dept. of Commerce).

* Codes that contain both information and non-information activities.

Source: Rubin, M. and E. Taylor (1981, pp. 167-9).

Table 11

Differences between the Industrial Typologies of Rubin-Taylor (1981) and Porat-Rubin (1977)*

1) Additions made by Rubin-Taylor, compared to Porat-Rubin

108	Iron and ferroalloy ores mining (some items)
1112	Coal mining (some items)
1213	Lignite and bitumen mining (some items)
138	Crude petroleum and natural gas (some items)
148	Non-metal mining (some items)
2754	Some items in engraving and commercial printing
2795	Some items in lithographic plate making
60	Some items, as Porat did not include all banking services
61	Some items, as Porat did not include all credit agencies (less farm credit)
63	Some items under "Insurance", as Porat dit not include all
64	Insurance services
7394	Some items under "Equipment and Parts Leasing"
762 to 764, 7699	Some repair services

2) Deletions made be Rubin-Taylor, compared to Porat-Rubin

a) Does not include all elements of the Porat-Rubin, only some under:

2642	Envelopes
274	Various publications
2751-2	Commercial printing; lithography and typography
84	Museums, art galleries, zoos and botanical gardens

b) Completely excludes:

15, 17	Maintenance and repair on information buildings
2893	Printing ink
2895	Carbon paper

* The codes used are U.S. SIC codes (1970).

galleries, zoos and botanical gardens, as well as printing and publishing. Nonetheless, the typology put forth a broader definition of information industries. Table 12 presents the elements missing in the Rubin and Taylor typology in order to arrive at this definition. For the most part, the Porat and Rubin study also excluded grading, inspection and control services related to fishing, textiles, agriculture. fishing, transportation and tourism. Other discrepancies are the result of the more discriminating selection made by Rubin and Taylor as regards to printing and publishing, security and commodity brokers, business services, etc. Porat and Rubin and Rubin and Taylor both included business, professional, union and political (and possibly religious) associations, while the OECD study did not.

d) Sherman Robinson (1986)

Sherman Robinson study of the 1977 Information economy was largely based on that of Porat and Rubin (1977) for 1977[1]. He used the input-output tables updated by the University of California at Berkeley, estimating the primary information sector in the U.S. at 30% of national income in 1977. This is higher than the 25.1% evaluated by Porat and Rubin for 1967, and the 24.8% Rubin and Taylor figure for 1972. The author's industrial breakdown, however, was not as detailed as that of Porat and Rubin. In that sense, his results "should thus be seen as only illustrative of the orders of magnitude"[2] His typology is listed in Table 13. At this level of grouping, the industries studied are comparable to those studied by Porat and Rubin (1977) and Rubin and Taylor (1981). He is even closer to Porat and Rubin than the Rubin and Taylor study, including, for example, ink manufacturers (27) and maintenance and repair on information buildings (12).

e) Research on Asia and Oceania (1980 to 1986)

A number of studies on Asia and Oceania originated from the analyses of Lamberton and Barnes (1977)[3] and the OECD (1981) studies of Australia. Neil Dias Karunaratne and Alan D. Cameron from the University of Queensland (Australia) estimated the share

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1 ROBINSON, Sherman (1986).

2 ROBINSON, Sherman (1986, p. 184).

3 Quoted by KATZ, Raul L. (1986).

Table 12

Differences between the Industrial Typologies of Rubin-Taylor (1981) and l'OECD (1981, 1986)*

1) Additions made by the OECD, compared to Rubin-Taylor

1120 Contract inspection, testing and grading of agricultural products, record services
1302 Fishery inspection services
2100 Textile grading services/factories
3200 Wallet manufacture
3529 Ink and carbon black
3822 Agricultural grading machinery
7111 Railroad clearing houses
7132 Flying control services operations; radar station operations
7191 Inspection/sampling services connected with transportation; tourist and travel agencies

Some items under:

3420 Printing and publishing: commercial printing, various printing, lithographic plate making
5000 Maintenance and repair on information buildings
8102 Security and commodity brokers
8329 Business services
9420 Museums, art galleries, zoos and botanical gardens

2) Additions made by Rubin, compared to the OECD

9350 Business, professional and union associations
9399 Political associations (some items)

* The codes used are from the United Nations ISIC, Serie M: No. 4, Revision 2, Add. 1, 1971.

Table 13

Robinson (1986): Information Industrie*

CONSTRUCTION INDUSTRIES

11 Information buildings
12 Maintenance & Repair on Information Buildings

NONDURABLE GOODS INDUSTRIES

24 Paper (for printing, excluding boxes)
26 Printing & Publishing
27 Ink

DURABLE GOODS INDUSTRIES

23 Office Furniture & Equipment
48 Machinery for Printing & Paper
51 Computer, Calculators & Office Machines
53 Electronic Measuring Instruments
56 Radio, TV, & Communication Equipment
57 Electronic Components
58 Miscellaneous Electronic Instruments
62 Mechanical Measuring & Control Instruments
63 Photographic & Related Equipment
64 Advertising Signs & Displays

SERVICES INDUSTRIES

66 Telecommunication (excluding Radio & TV)
67 Radio & TV Broadcast & CATV
69 Trade Margin on Information Goods
70 Finance & Insurance
71 Real Estate
72 Repair of Radio & TV Equipment
73 Miscellaneous Business Information Services
76 Motion Pictures & Theatre
77 Medical, Education, & Non-profit Services
78 Postal Service
82 Office Supplies
84 Federal Government Information Workers

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* The codes used are from the Bureau of Economic Analysis (U.S. Dept. of Commerce)

Source: ROBINSON, Sherman (1986, p. 198).

of the primary and secondary information sectors at 16% and 13% of the value added in Australia (1968-1969)[1]. They later proceeded to evaluate the primary information sectors (PIS) in Australia and Papua-New Guinea. The Australian PIS was 18.5% of the national value added (1974-1975), compared to 11.6% for Papua-New Guinea (1972-1973)[2]. In 1977-1978, the Australian PIS reached 24.5% of the national value added, compared to the 1975 figures of 17% for the Fiji Islands, 19% for Papua-New Guinea, 9% for Indonesia, 16% for Malaysia, 13% for the Philippines and 10% for Thailand[3].

The typology used for information industries is similar to the OECD typology. For example, the reader will find in Table 14 the typology used for Australia, and in Table 15 that used for Papua-New Guinea. Analysis in the first case was more detailed (see Table 14, column D) than in the second. The 25 Australian codes correspond to the 19 Papua-New Guinea codes (Table 15).

In 1983, Meheroo Jussawalla and Chee-Wah Cheah of the East-West Center (Honolulu) conducted a study on Singapore. They estimated the primary information sector at 24% for 1973. Their industrial typology is presented in Table 16. A number of information activities were excluded by the authors due to a lack of more detailed data: services related to fishing and agriculture; film production, distribution and presentation; and repairs of electronic, audio and video equipment. Their typology would initially appear to be closer to that employed by Porat and Rubin (1977) than to the OECD typology (1981), if an exception is made for tourism and travel agencies (industry #9).

In 1984, Hans-Jurgen Engelbrecht of the University of Queensland (Australia) gave a speech at the East-West Center (Honolulu) on the information economy in the Republic of China and Taiwan. In 1986 he published an evaluation of the primary information sector in the Republic of Korea. Korean information industries represented 12.9% of the total value added in 1975, compared to 18.1% five years later. Table 17 lists the industrial codes used. The author followed the OECD classification of information industries. Inspection, testing and grading services appear, however, to be absent.

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1 KARUNARATNE, N.D. and Alan D. CAMERON (1980).

2 KARUNARATNE, N.D. and Alan D. CAMERON (1981).

3 KARUNARATNE, N.D. (1985).

Table 14

Karunaratne and Cameron (1980): The Primary Information Sector in Australia

(a) ASIC SECTOR CODE BASED ON ABS I-O TABLE	(b) TYPOLOGY OF PRIMARY INFORMATION COMMODITIES	(c) GROSS COMMODITY OUTPUT ($ million)	(d) INFORMATION AS PERCENTAGE OF ASIC CODE GROSS COMMODITY OUTPUT (%)	(e) GROSS INDUSTRY OUTPUT ($ million)
02.00	Services to Agriculture	220,8	100	220,8
16.00	Exploration	138,0	100	138,6
25.04	Furniture	27,6	15	27,6
26.01	Office paper, newsprint	145,6	43	140,6
26.04	Newspapers, Books	376,1	100	389,7
26.05	Printing	364,4	100	359,1
27.07	Inks	15,2	8	16,7
33.01	Scientific instruments	143,3	91	141,3
33.02	T.V. Radio & communications equipment	368,5	100	404,5
34.04	Signs writing equipment	60,8	100	60,2
41.02	Other building and construction	538,1	15	532,6
46.01	Wholesale Trade	490,4	16	490,4
48.01	Retail Trade	261,4	10	261,4
48.03	Other Repairs	62,8	8,7	62,8
55.01	Communication	791,2	100	791,2
61.01	Banking	615,4	100	620,6
61.02	Finance and Life Assurance	276,2	70,9	276,2
61.03	Other Insurance	337,4	100	337,4
61.04	Real Estate	140,2	18	140,2
61.05	Business Services	798,5	90	798,5
71.01	Public Administration	358,5	36	360,7
81.01	a) Doctors-private	110,1	12	110,1
	b) Child health service	10,6		10,6
82.01	Education, Libraries	861,6	100	861,6
83.01	a) Business Organizations	32,3		32,3
	b) Employment Services	16,7		17,0
	c) Political Assoc.	15,0	47	15,0
	d) Research Institutions	81,7		81,7
91.01	a) Motion Pictures	68,6		68,6
	b) TV & Radio stations	153,4		153,4
	c) Live performances	26,2		26,2
	d) Lottery & Bookmakers	64,2	73	64,2
	e) TAB	79,2		
	f) Motion & TV Hire to Overseas	26,6		26,6
99.01	Business Expenses	1393,0	50	1393,0
	TOTAL	9469,6	16,6	9511,4

Table 14

Karunaratne and Cameron (1980): The Primary Information Sector in Australia (cont.)

Notes:

(a) ASIC CODE SOURCE. Refers to the industry within which the primary information commodity is classified in the 1968-9 Input-Output Tables.

(b) INFORMATION COMMODITIES. The information commodity classification adopted is that used in Appendix B of the I-O table of 1968-69.

(c) GROSS COMMODITY OUTPUT. These values for the most part are derived directly from Appendix B of the I-O table of 1968-69.

(d) These figures show the proportion of commodity output under the conventional output classification represented by information.

(e) Gross industry output differs from commodity output to the extent that secondary outputs are produced by each information industry.

Exceptions list:

1) Furniture and Construction used directly for informational purposes. In the absence of specific data for Australia the information component of total furniture and construction commodity output for the U.S. (Porat, 1976; 16) is used as an approximation.

2) Information wholesale and retail trade and repairs components of total commodity output are estimated on the basis of data compiled within the ABS Economic Census 1968-1969.

3) Business services are designated as informational on the assumption that a substantial proportion of non-specified expenditure on services takes the form of information commodities which conventional accounting practice fails to recognize separately.

4) Business expenses are those miscellaneous commodities not directly attributable to the other commodity classifications. Again as in the case of business services a high proportion of this output is allocated to information. However, the proportion in this instance is not as high because of the assumed diversity of commodities under this heading.

Source: KARUNARATNE, N.D. and Alan D. CAMERON (1980, p. 192).

Table 15

Karunaratne and Cameron (1981): Comparison of the Primary Information Sectors in Papua-New Guinea and Australia

Australia	Papua New Guinea	Categories
1. Services to agricultural exploration	1. Consultancy	
20. Public administration	2. Medical info. services	
21. Health	3. Marketed govt. info. services	
23. Information organisations	4. Free govt. info. services	1. Knowledge production
24. Media services	5. Business expenses	
25. Business expenses		
22. Education and libraries	6. Education	2. Knowledge distribution
4. Newspapers, books	7. Printed matter	
14. Communications	8. Communications	3. Communications-media
18. Real estate	9. Property management	
19. Business services	10. Advertising	4. Search and co-ordination
16. Finance, assurance	11. Bank services	
15. Banking		5. Risk management
17. Other insurance		
5. Printing		6. Printed media processing
3. Office paper, newsprint	12. Printing inks	
6. Inks	13. Newsprint	
7. Scientific instrum.	14. Telecommunications equip.	7. Information goods manu-facturing
8. Communications equip.	15. Duplicating equip.	
9. Signs, writing equip.		
11. Wholesale trade	16. Info. w/sale and retail	
12. Retail trade		8. Wholesale and retail trade in information
13. Repairs		
2. Furniture	17. Info. premises construction	
10. Building construction	18. Information furniture	9. Info. support facilities
	19. Info. premises rental	

Source: KARUNARATNE and CAMERON (1981, p. 126).

Table 16

Jussawalla and Cheah (1983): The Primary Information Sector in Singapore

INDUSTRIES	74-order 10 Group no.	Scalar
(A) The production of information goods		
(1) Manufacture of pulp and paper	25	1,000
(2) Manufacture of stationery, paper, and non-paper related products	26 55	0,335 0,014
(3) Printing and publishing	27	1,000
(4) Manufacture of inks and carbon black	32	0,095
(B) The processins and distribution of information - 'hardware'		
(5) Manufacture and repair of non-electronic computing, data-processing, and office machinery	45	0,861
(6) Manufacture of cables and wires	46,47	0,161
(7) Electronic and telecommunication equipment	48	1,000
(8) Precision instruments and devices	53	1,000
(C) The processing and distribution of information - 'software'		
(9) Tourist and travel agencies in air transport and shipping	63	0,327
(10) Risk management services in finance	65	0,676
(11) Insurance agents, appraisers, and consultants	66	0,070
(12) Real estate agents and appraisers	67	0,135
(13) Professional services	68	1,000
(14) Education	70,73	0,158
(D) Commerce		
(15) Commerce; wholesale and retail trades in information goods	60	0,108
(E) Information infrastructure		
(16) Postal, telephone, and telecommunications (PTT)	64	1,000
(17) Public administration and development services	70,73	0,494

Table 16

Jussawalla and Cheah (1983): The Primary Information Sector in Singapore
(cont.)

(F) <u>The production of non-information goods</u>	
(18) Manufacture of non-information goods	5-24, 26, 28-47, 49-52, 54-5[illegible]
(G) <u>The production ou non-information services</u>	
(19) Services in transport storage, finance, insurance, real estate, recreation and culture, welfare	63-67, 69, 70-74
(H) <u>Commerce - net of trade in information goods</u>	
(20) Commerce in non-information goods, including hotels and restaurants	60, 61, 62
(I) <u>Primary sectors</u>	
(21) Livestock	1
(22) Fishing and other agriculture	2-3
(23) Quarrying	4
(J) <u>Utilities</u>	
(24) Gas, water, and electricity	56-58
(K) <u>Construction</u>	
(25) Construction, viz., civil works and building	59

"The first 17 activities are obtained by applying the relevant scalar to the corresponding I-O group in the original 74-order table. For example, activity number 5 is 86.1% of the total output of I-O group number 45. The residual or non-information component of I-O group 45 is then aggregated into activity number 18. The last eight activities portray 'the rest of the economy' in six major sectors which are defined by collapsing the original 74-order table. These sectors also include residual values of non-information components derived from the computation of the first 17 activities (see example above)."

Source: JUSSAWALLA, M. and C.-W. CHEAH (1983, p. 175-6).

Table 17

Engelbrecht (1986): The Primary Information Sector in the Republic of Korea

Sector[a]	1975		1980		Components
	Source[b] sector	Output Information intensity coefficients[c]	Source sector[d]	Output Information intensity coefficients[c]	
1	67	0.6180	66	0.4771	Newsprint, printing paper, newspapers, books and periodicals, other printing and publishing, notebooks, writing pads, certain processed papers
	68	0.0943	67	0.1275	
	69	1.0	68	1.0	
2	65	0.1158	62	0.1048	Office furniture and machinery, office supplies
	107-110	0.0118	100-102	0.0169	
	115	0.0348	106	0.95	
	162	1.0	160	1.0	
3	120-123	1.0	112-115	1.0	Electronic and communication equipment
4	128-129	0.9768	121-123	0.9568	Precision instruments and apparatus (measuring, medical, and optical instruments)
5	86-90	0.0878	81	0.3194	Photochemical and sensitized materials, inks, informational electrical and non-electrical machinery, stationery
	94-99	0.0004	88	0.0038	
	114	0.0804	105	0.0404	
	117-119	0.0872	109-11	0.1915	
	130	0.0490	124	0.0590	
6	131-133	0.0653	125-127	0.0782	Informational infrastructure construction
	134-135	0.0641	129	0.3056	
7	139	0.0664	134	0.0970	Distribution of information goods and services
8	149	1.0	144	1.0	Communication
9	150-151	0.9513	145-146	0.9530	Finance and insurance
10	152-153	0.1684	147-148	0.2062	Real estate brokerage and rental
11	159	0.9866	156	1.0	Legal and other professional business services, advertising, certain rental and leasing services
			157	0.2500	
12	142-148	0.0047	137-143	0.0049	Informational transportation related services, public administration (informational component), health consultative services, information organisations and institutions, informational recreation services, informational personal services
	154	0.5343	149	0.5253	
	156	1.0	152-154	0.0783	
	158	0.6188	155	0.8045	
	160	0.6967	158	0.5802	
	161	0.0372	159	0.0384	
13	155	1.0	150-151	1.0	Education and research

a Information sectors in reclassified I/O table.
b Refers to sector codes of 164 sectors I/O table, Republic of Korea, 1975
c The information intensity coefficient equals 1 when the entire sector code production is considered informational.
d Refers to sector codes of 162 sectors I/O table, Republic of Korea, 1980

Source: ENGELBRECHT, Hans-Jürgen (1986, p. 189).

f) The Canada Consulting Group (1984)

There has only been one group in Canada, the Canada Consulting Group, that has endeavoured to draw up a list of information industries (1984). As was the case with Porat and the OECD, two information sectors were distinguished. The first generated 23% of GDP in 1971, compared to 27% in 1981. The second accounted for 12% in 1971, compared to 20% ten years later, when 43% of information workers lived in Ontario.

The degree of aggregation tended to be rather high (see Table 18), with a three-digit industry classification, compared to the fourdigits usually employed in studies by the OECD, Rubin and Taylor or Porat and Rubin.

The typology differs in virtually the same respects as the Porat study does with the OECD studies, except perhaps for a more extensive grouping for insurance, real estate and various business services. It is, however, more discriminating as regards to wholesale and retail trade.

Compared to Porat's typology, the Canada Consulting Group (CCG) eliminated a number of activities: paper and printing industries machinery, ink, office supplies (except paper), office furniture, construction and maintenance of office buildings, medical services, repair and rental of information machines and equipment, zoos and botanical gardens. Wholesalers dealing in musical instruments, photographic equipment and supplies, books, periodicals and newspapers, as well as motion picture equipment and machinery, were also excluded.

Unlike Machlup, the CCG ignored printing machinery, office supplies, education outside academic institutions, repair and maintenance of equipment, conventions, some medical and hospital services, and some recreational and entertainment services. On the other hand, the CCG added the manufacture of watches and clocks, museums and art galleries, retail trade in radios, televisions and telephones, bookstores, etc.

Table 18

Canada Consulting Group (1984): The Primary Information Sector

SIC 1970*	INDUSTRIES
286 to 289	Printing, publishing and related industries
318	Machines and equipment for offices, stores and businesses
334	Phonographs, radio and television sets
335	Communications and other electronic equipment
391	Scientific and professional equipment
543 to 548	Communications industry
621	Electrical and electronic machines, equipment and supplies - wholesale
6442	Other television and radio supplies - retail
691	Stationery and bookstores - retail
701	Banks and other deposit institutions
705	Exchange agents and security brokers
721	Insurance
735	Insurance and real estate agencies
801 to 809	Education
841, 842	Film production and distribution, audio-visual equipment
851 to 869	Business services
902 to 991	Government (except national defence)

* 1970 SIC (Standard Industry Classifications) codes presumably used.

Source: CANADA CONSULTING GROUP (1984, p. 56).

1.2 Telematics Industries or Industries Involved in the Computerization process

1.2.1 Nora and Minc (1978)

In 1978, Simon Nora and Alain Minc published a report for the President of France entitled "L'informatisation de la société" (The Computerization of Society). The work focused on recent developments in computer technology, rather than on information or knowledge concepts. In this respect, a neologism was created "telematics". The term refers to the convergence of various technical fields with information systems, chiefly the telecommunications field. The distribution of goods and services resulting from telematics gives rise to the computerization of activities. According to the authors, this process has three major effects:

- a productivity effect;
- a direct industrial effect;
- a restructuring effect.

The productivity effect is well known. Computer capital allows organizations to increase their productivity by replacing manpower and/or assisting workers in carrying out their work. The direct industrial effect originates from the creation of a productive sector that produces telematic goods and services. The restructuring effect involves an industry completely re-organizing its goals, products and manufacturing and distribution processes. In that case, automation leads to industrial redeployment and a restructuring of the economy. All industries are affected by telematic goods and services.

In the authors' opinion, the industries behind the restructuring process are the following manufacturers of telecommunications products (goods and services), manufacturers of computer equipment, computer servicing and consultation industries, computer parts manufacturers and data bank services. The consequences are particularly extensive for certain tertiary sector activities: banking, insurance, government (postal services, social security) and office activities in general.

1.2.2 Roland Jouandet-Bernadat (1979)

In 1979-80, the GAMMA Institute published ten research reports on the "société informatisée" (computerized society), including a report by Roland Jouandet-Bernadat. Drawing from the works of Marshall McLuhan and Nora & Minc, he felt that the real industrial revolution of our era was the computerization of our society. In order to focus on part of this phenomenon, the idea of a "telematics complex" was employed, grouping all industries that produce goods and services directly related to telematics. Table 19 outlines these activities in detail. The author then pursued the input-output analysis in order to distinguish industries that indirectly provide goods and services from industries in the telematics complex.

Roland Jouandet-Bernadat used a three-digit classification to define his telematics complex. A number of activities far removed from the telecommunications and computer fields were included, notably in the SIC codes 318 and 678. As the author pointed out, it was a basis for further study. Based on this approach, 2% of Canadians were employed in the telematics industry in 1976. Moreover, using data on informatics and communications professions, he noted that the ten following industries are characterized by a level of computerization that is considerably higher than the Canadian average: insurance, non-electrical equipment manufacturing, financial institutions, communications, mineral fuels extraction, petroleum and coal products manufacturing, business services, provincial governments, public utilities and the federal government. The insurance industry is clearly ahead of the other industries.

Table 19

Jouandet-Bernadat (1979): The Telematics Complex

SIC 1970	INDUSTRIES
318	Offices and Store Machinery Manufacturers
334	Manufacturers of Household Radio and Television Receivers
335	Communications Equipment Manufacturers
543	Radio and Television Broadcasting
544	Telephone Systems
545	Telegraph and Cable Systems
678	Radio, Television and Electrical Appliance Repair
853	Computer Services
-	Cable Television Industry

1.2.3 Legoff, Lapointe and associates (1984)

In 1981, the Quebec Department of Communications financed an economic analysis of telematics services in Quebec. Jean-Pierre Legoff, Alain Lapointe and Roland Jouandet-Bernadat conducted the study. The latter died in the course of the study, but his colleagues continued with the project, using a conceptual framework he had drawn up (Figure I).

Within the telematics complex, the authors focused exclusively on telematics services. Radio broadcasting was excluded from the study as it is little affected by these technological innovations as far as content, method of transmission and ratings are concerned. The written communications industry (newspapers, postal services and offices) was also ignored. As far as the production of telematics equipment is concerned, the authors referred to a Quebec Department of Industry and Commerce study (1981). Their analysis of the electronics industry was based on the following four activities:

- Offices and Store Machinery Manufacturers (SIC 1970: # 318);
- Manufacturers of Household Radio and Television Receivers (SIC 1970: # 334);
- Communications Equipment Manufacturers (including electronic parts) (SIC 1970: # 335);
- Scientific and Professional Equipment Industries (SIC 1970: # 391).

1.2.4 Institut national de productivité (1984) (National Productivity Institute)

The Quebec Department of Science and Technology mandated the INP ("National Institute of Productivity) to "determine to what extent and how quickly informatics (information processing) has penetrated the various sectors of the economy"[1]. In 1984, Louise Piché-Grenache presented a summary of opinions and information on the matter. Emphasis was placed on electronic goods produced by

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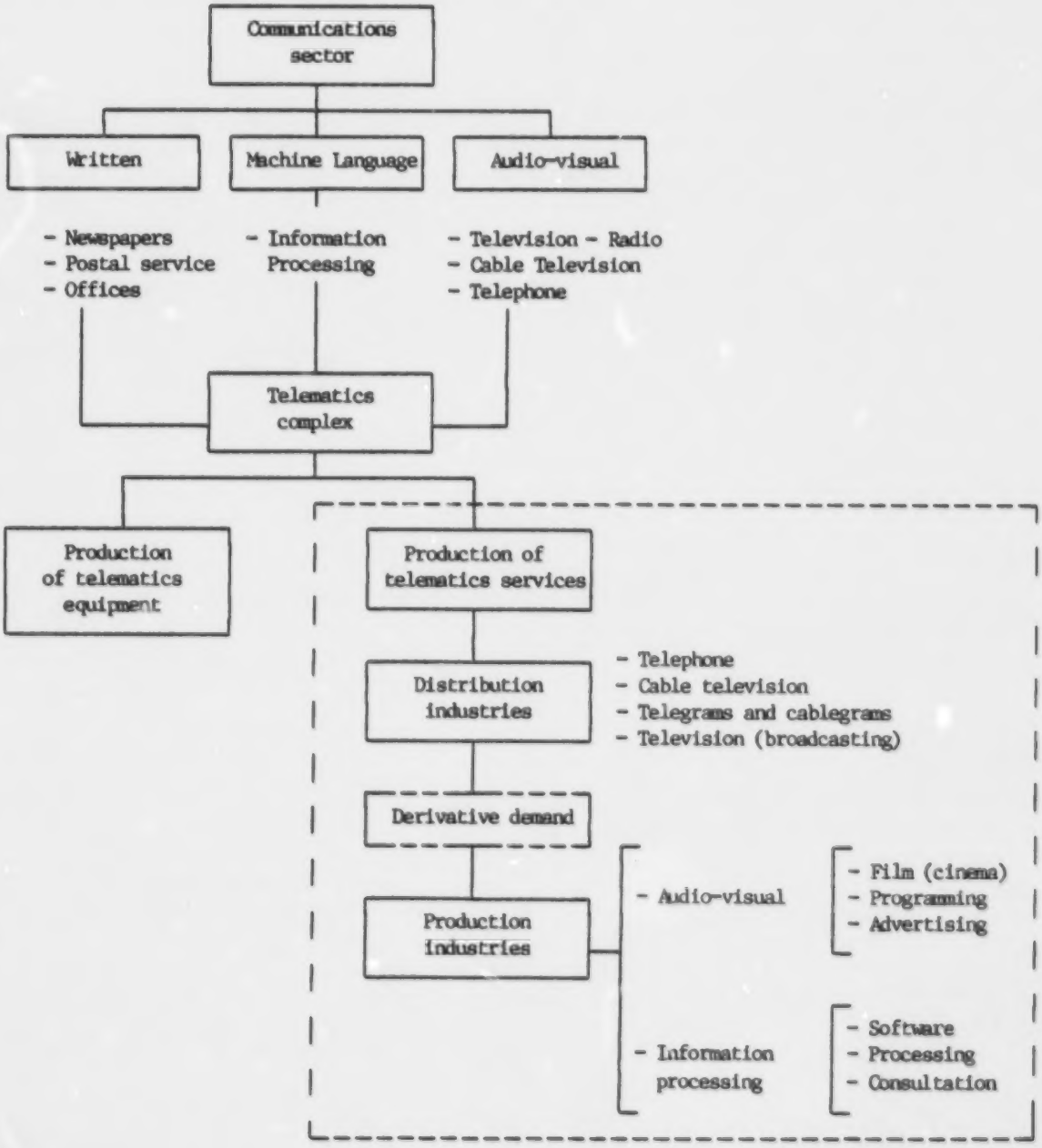
[1] PICHE-GRENACHE, Louise (1984, p. 1).

Figure I

Legoff, Lapointe and coll. (1984): The Communications Sector and the Telematics complex



industries involved in telecommunications, office machines, industrial and scientific instruments and consumer goods; more specifically computers, minicomputers, microcomputers and their applications in office automation (word processing machines), robotics (robots), telematics (terminals) and CAD/CAM.

There is no room here to list the various indicators used and the results obtained. Despite their extensive grouping, Tables 20 and 21 are of interest. The electronics phenomenon is present chiefly in "socio-cultural, commercial and personal services", "finance, insurance and real estate", "wholesale and retail trade", "manufacturing" and "government".

1.2.5 Agence de l'Informatique (1986)
The Informatics Agency

The "Agence de l'Informatique" (1986) (The Informatics Agency France) adopted a broader definition of the technological phenomenon under study. As we enter an era of digitized information and electronization, it is no longer simply a question of informatics converging with telecommunications[1]. Sound, images, texts and physical data are digitized. Electronization is taking hold in the form of silicon in robots and even in household appliances. As stated by the Agency:

> "When a particular function is useful in a number of applications and when a widely accepted program has been perfected, it is economically worthwhile to integrate it on a permanent basis within a specialized microprocessor that can be used in electronic cards and machines. It will no longer be necessary to program this function, which can be the sine or mean on a calculator, a speech recognition program, graphic processing, computer communication or functions for electronic components in industrial or household robots, etc." [2]

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[1] Nora and Minc (1978) also mentioned robotics, but the emphasis was clearly on telematics. It must also be acknowledged that between 1978 and 1986 several technological innovations and applications considerably modified the scope of industrial machinery and consumer goods.

[2] AGENCE DE L'INFORMATIQUE (1986, p. 26).

Table 20

Consumption of Electronic Goods in Quebec in 1981 per Economic Sector (millions of $)

SECTOR	Electronic goods (of less than $500,000) overall		Office automation		Telematics		Sector's percentage of GDP (%)
	$M	%	$M	%	$M	%	
Primary	9	4	2	10	1	2	3
Construction	7	3	1	3	3	4	5
Manufacturing	39	18	4	27	10	15	25
Wholesale & Retail Trade	52	24	2	10	19	28	13
Finance, Insurance and Real Estate	26	12	1	8	3	5	12
Transportation, Communications & Electricity	9	4	1	8	4	6	14
Socio-Cultural, Business and Personal Services	61	28	4	27	24	35	22
Government	15	7	1	7	3	5	6
TOTAL	$ 218 M	100%	$ 16 M	100%	$ 67 M	100%	100%

Source: MINISTÈRE DES COMMUNICATIONS (Québec). Étude sur le profil des importations et des exportations québécoises en Informatique, Quebec Department of Communications, 1983 in PICHE-GRENACHE, L. (1984, p. 9).

Table 21

Number of Electronic Goods in Quebec
per Economic Sector (1982, 1985)

ECONOMIC SECTOR	Computers		Mini-computers		Micro-computers		Office Automation		Robotics		Telematics		CAD	
	1982	1985	1982	1985	1982	1985	1982	1985	1982	1985	1982	1985	1982	1985
Primary	61	100	50	80			50	100						
Construction	30	30	36	80			450	700					4	10
Manufacturing	400	570	331	310			1 600	2 500	13	200			18	47
Wholesale & Retail Trade	210	300	195	350			1 600	2 700						
Finance, Insurance and Real Estate	77	100	57	100			1 700	2 800						
Transportation, Communications & Electricity	166	180	130	250			900	1 600	12	40				
Socio-Cultural, Business and Personal Services	271	381	195	420			3 000	5 000	1	10				
Government	137	200	78	110			1 100	1 900						
Other	60	140	82	300			1 000	1 500	16	20			3	8
TOTAL	1 412	2 000	1 154	2 000	25 000	50 000	11 400	18 800	42	270	68 000	137 000	25	65

Sources: Canadian Information Processing Society and INP, in PICHE-GRENACHE, L. (1984, p. 11).

The Agency also noted a number of changes in the behaviour of various sectors of the economy:

1) Due to the growth and inroads made by informatics, companies working with related technologies are greatly attracted to this sector. They generally produce electronic goods and equipment, digitally controlled machine tools, flexible workshops, robots and telephone or office equipment.

2) Firms involved in providing business services gradually tend to offer informatics services. This group includes firms of consulting engineers, accountants, auditors, personnel training organizations, management consultants, etc. Often this orientation is a result of customer demand, rather than the firm's business strategy.

3) Distribution networks are redefined. Major non-specialized distribution networks are seeking to establish relations with informatics partners. The objective is to market products manufactured chiefly by small and medium-sized firms. These major distributors generally deal in electric appliances or consumer electronics, or are involved in the specific distribution of goods for an industry, sector or profession.

4) Beyond a certain threshold of computer use, users often offer informatics or computerized products. This is the case not only for publishing houses, but also for banks, printing firms and aviation companies.

Given such a volatile, diverse and widespread phenomenon in all economic sectors, the authors acknowledged that it is extremely difficult to pinpoint trends and schematize the computerization process. Table 22 nonetheless presents an industrial typology that is useful in both the medium and short term. Information and related industries are identified, as are activities that are greatly influenced by the process. In the long term, all industries could be listed.

Table 22

Agence de l'informatique Industrial Typology (1986)*

1) Informatics:

- Manufacturing
  . equipment
  . computer peripherals

- Services
  . service and engineering firms (SSII) (7701)
  . service and consulting firms (SSCI) (7703 and 7704)

- Distribution

2) Grey Area: activities integrating value added by computers or computer consultation

- Technical studies (7701)

- Consultation - information and documentation (7707)

- Miscellaneous consulting firms (7712)

3) Chartered Accountants (7709)

4) Highly Affected Area:

- Computerization equipment (2815)

- Miscellaneous equipment:
  . office machines (2702)
  . telegraph (2911)
  . telephone (2914)
  . professional electronic equipment (5804)
  . office equipment - wholesale (5911)
  . office equipment - leasing (8003)

- Business services (7714)

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* The codes in parentheses correspond to the industrial classification employed by the "Institut National de la Statistique et des Études Économiques" (INSEE)

Source: AGENCE DE L'INFORMATIQUE (1986, p. 56).

1.3 The Search for a Compromise between the Two Approaches

1.3.1 Yoneji Masuda (1980)

Between 1970 and 1974, the work of the JACUDI group drew attention to desirable information activities and computerization for Japanese society. The executive director Yoneji Masuda expanded on the topic in a book published in 1980.

On an economic level, the phenomenon has three stages of development:

1) Information-related industries become the driving force behind the economy, to such an extent that a quaternary sector must be established. This new sector includes goods and services produced by information industries, knowledge, arts and ethics industries. The first two are considered as future key industries;

2) Computerization of industries through information equipment;

3) Development of industry systems, i.e. industrial networks formed by relations with information industries such as the health industry, which includes food, sports, pharmaceuticals, medical services and information, all of which are organically inter-related.

Masuda therefore simultaneously considered information and technology, information industries and the computerization of industry. Figure II presents his typology of the quaternary sector, which entails essentially the knowledge industry and information industries or sectors.

Information industries as such produce, transform and offer cognitive information, and manufacture and sell equipment specifically designed for this purpose. By cognitive information, Masuda means "an informed situational relation between a subject and an object that makes possible the action selection by which the subject itself can achieve some sort of use value"[1]. Knowledge is generalized and abstracted cognitive information allowing for an understanding of the cause/effect relationships of a specific

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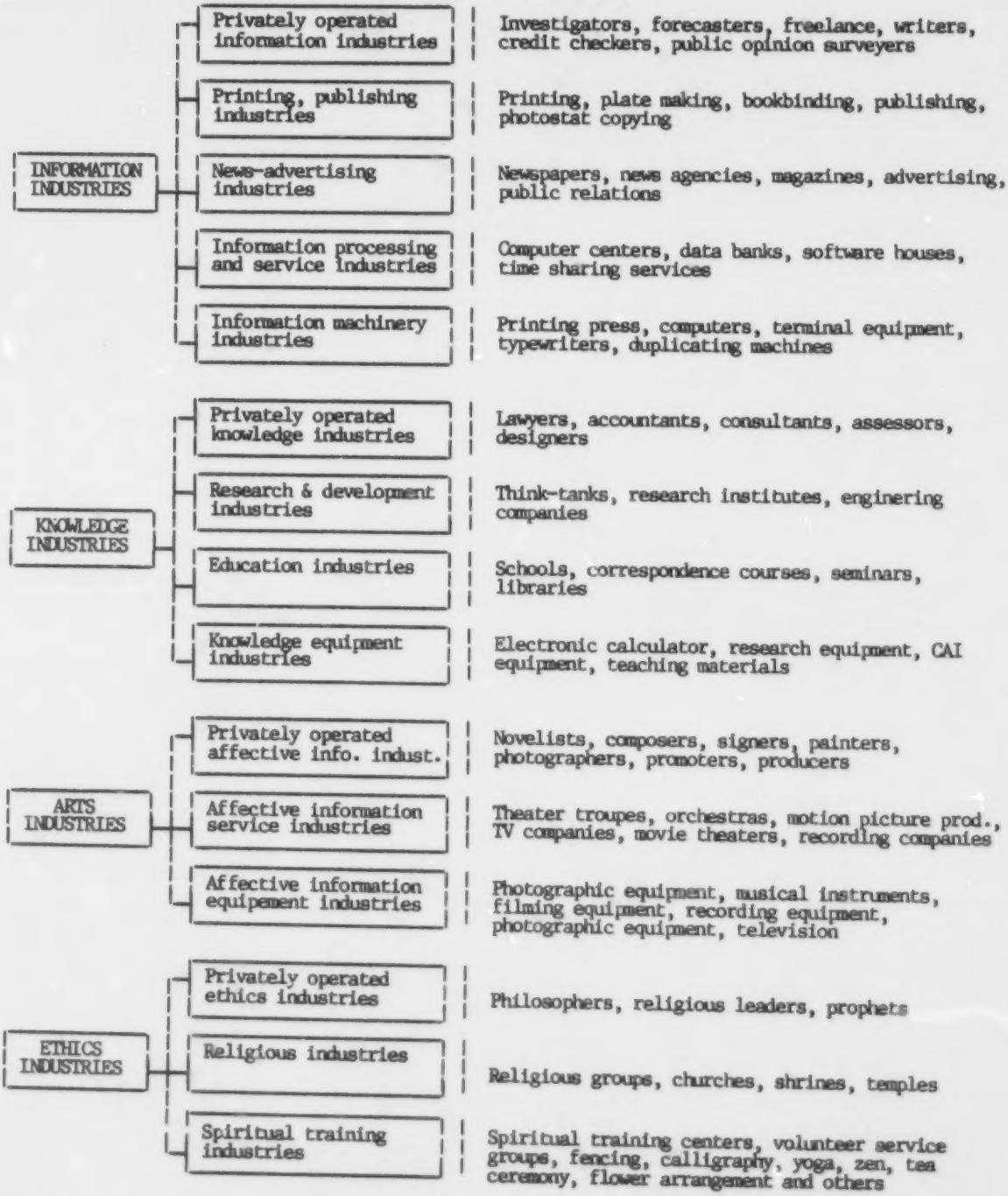
[1] MASUDA, Y. (1980, p. 55).

Figure II
The Quaternary Sector according to Masuda (1980)


INFORMATION INDUSTRIES
Privately operated information industries
Investigators, forecasters, freelance, writers, credit checkers, public opinion surveyers
Printing, publishing industries
Printing, plate making, bookbinding, publishing, photostat copying
News-advertising industries
Newspapers, news agencies, magazines, advertising, public relations
Information processing and service industries
Computer centers, data banks, software houses, time sharing services
Information machinery industries
Printing press, computers, terminal equipment, typewriters, duplicating machines
KNOWLEDGE INDUSTRIES
Privately operated knowledge industries
Lawyers, accountants, consultants, assessors, designers
Research & development industries
Think-tanks, research institutes, enginering companies
Education industries
Schools, correspondence courses, seminars, libraries
Knowledge equipment industries
Electronic calculator, research equipment, CAI equipment, teaching materials
ARTS INDUSTRIES
Privately operated affective info. indust.
Novelists, composers, signers, painters, photographers, promoters, producers
Affective information service industries
Theater troupes, orchestras, motion picture prod., TV companies, movie theaters, recording companies
Affective information equipement industries
Photographic equipment, musical instruments, filming equipment, recording equipment, photographic equipment, television
ETHICS INDUSTRIES
Privately operated ethics industries
Philosophers, religious leaders, prophets
Religious industries
Religious groups, churches, shrines, temples
Spiritual training industries
Spiritual training centers, volunteer service groups, fencing, calligraphy, yoga, zen, tea ceremony, flower arrangement and others

Source: MASUDA, Y. (1980, p. 89).

phenomenon in an external environment. Arts industries involve affective information, that is information that evokes sensitivity and emotion.

Table 23 illustrates industry systems, an approach closely related to the computerization of the economy and the industrial restructuring that it involves.

1.3.2 Marchand and Horton (1986) and the Quebec Department of Communications (1987)

In 1986, D.A. Marchand and F.W. Horton[1] presented a typology of U.S. electronic information processing industries, inspired largely by the work of Sena Black (1987). Revenue generated by these activities was evaluated at $201 billion U.S. for 1983. Table 24 details these estimates and gives the industry groupings.

In the spring of 1987, the Quebec Department of Communications presented a seven-volume analysis of electronic information[2].

This is defined as being "any information, the processing of which (gathering, handling, storing and distributing) is carried out entirely or in part by electronic means"[3].Emphasis was given to the electronic information industry, i.e. activities connected with the marketing of electronically processed information. Within the Marchand and Horton typology (1986), the authors distinguished two types of industrial participants:

- the electronic information industry as such involves goods and services that ensure "the processing of information (creating, gathering, handling, distributing and stocking) using new high-performance technologies (informatics, new transmission procedures, laser optics)[4]. This includes data bank suppliers and producers, data bank users and distributors, and information brokers;

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1 MARCHAND, Donald A. and Forest W. HORTON (1986).

2 A series of seven documents. The most relevant as far as industrial typology is concerned is MARTIN, André (1987).

3 ROMPRE, Michelle (1987, p. 11).

4 MARTIN, André (1987, p. 3).

Table 23

Masuda (1980) : Structure of the Industrial Matrix

by products	by systems	SYSTEMS INDUSTRIES: Distribution Industry	Integrated Transport Industry	Housing Industry	Regional Development Industry	Environment Industry	Marine Industry	Space Industry	Leisure Industry	Fashion Industry	Health Industry	Opportunity Development Industry
PRIMARY INDUSTRIES												
Agricultural Industries	Mechanized Agriculture										●	
	Broiler Industry										●	
Fisheries Industries	Fish Hatcheries						●				●	
Mining Industries	Offshore Oil Wells						●					
	Underwater Mining						●					
SECONDARY INDUSTRIES												
Light Industries	Manufactured Foods (Margarine, etc.)							●			●	
	Frozen Foods										●	
	Clothing							●	●	●		
	Cosmetics									●		
	Medical Supplies							●			●	
Heavy, Chemical Industries	Artificial Organs										●	
	Medical Engineering Equipment							●			●	
	Anti Air-Pollution Devices				●	●					●	
	Construction Equipment			●	●	●						
	Ambulances				●						●	
	Disaster Prevention Devices				●	●					●	
	Rack Style Warehouses		●									
	Deep Sea Submarines						●					
	Space Devices							●				
	Communications Satellites					●	●	●				
	Traffic Signal Equipment				●	●						
	Automated Commuter Transport		●		●				●			
Construction Industries	Prefabricated Houses			●	●							
	Mobile Homes			●					●			
	Hospitals				●						●	
	Highways		●		●	●			●			
	Land Development			●	●	●			●			
TERTIARY INDUSTRIES												
Utility (Light, heat and power)	Atomic Power					●						
	Solar Energy					●		●				
	Natural Gas											
Traditional public Utilities	Regional Heating and Airconditioning Facilities			●	●	●					●	
Freight Industries	Monorail				●							
	Container Transport	●	●									
Communications	Data Communications	●	●	●	●	●	●	●	●	●	●	●
Commerce	Supermarkets	●			●					●		
	Distribution Centers	●	●		●							
Warehousing	Warehouses	●	●									
Finance and Insurance	Opportunity Loans											●
	Housing Loans			●								
Personal Services	Medical Care				●	●	●	●			●	
	Human Docks				●						●	
	Athletic Clubs				●						●	
QUATERNARY INDUSTRIES												
Information Industries	Data Banks	●	●	●	●	●	●		●	●	●	●
	Computer Centers	●						●				
	Software	●	●	●	●	●	●	●	●	●	●	●
	Computers	●	●	●	●	●	●	●	●	●	●	●
	Terminal Equipment	●	●	●	●	●	●	●	●	●	●	●
Knowledge Industries	Think Tank	●	●		●	●	●	●	●		●	●
	Consultants								●		●	●
	Audiovisual Teaching Equipment								●			●
	CAI Equipment											●
	Color Television								●	●		●
Arts Industries	Movies								●	●		
	Plays								●	●		
	Records								●			
Ethics Industries	Spiritual Training Centers										●	●
	Religious Groups										●	●
	Volunteer Service Groups				●	●					●	●

SOURCE : MASUDA, Y. (1980, pp. 92-93).

- other electronic information processing industries are industries whose activities are connected to the information industry as such, i.e. manufacturers of computer and communications equipment, computer and telecommunications services, and software manufacturers (table 24).

The electronic information industry as such is currently assessed at $4 billion in the United States, compared to $70 million in Canada and a maximum of $10 million in Quebec[1].

The Quebec Department of Communications study (1987) looked at the issue from the point of the information economy, and also from that of the computerized economy. As was the case with Daniel Bell, the transition from an industrial to a post-industrial society was reviewed, with information and knowledge as the driving forces behind this change. In line with Porat (1977) and the OECD (1981), information and the information society were key concepts in the analysis. The foundations of this new society, however, are technological. Information technology (informatics) is an integral part of communications technologies (telecommunications infrastructure), as was the case with Nora and Minc (1978), or Roland Jouandet-Bernadat (1979). Generally speaking, traditional methods of handling information have been revolutionized, and new products and industries created. There is competition among industries that, in the past, were not in competition with each other. Electronic information is gradually becoming an element of strategic planning for businesses.

Table 25 presents a comparison of some industrial typologies described in the text, which will allow us to observe differences in approach more easily.

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[1] BELLEMARE, Louis (1987, p. 13).

Table 24

The Information Processing Industry:
Estimated Income for the U.S. in 1983
(in millions of $ U.S.)

Computer industry ($90,370)	Manufacturing ($57,750)	* Data processing equipment ($26,810) * Computer peripherals ($24,290) * Office equipment ($6,650)
	Services ($32,620)	* Processing services ($12,809) * Turnkey/integrated systems ($4,608) * Software ($7,943) * Professional services ($7,260)
Communications Industry ($99,543)	Manufacturing ($8,402)	* Telephones ($975) * PBX ($2,523) * Data communications ($3,477) * Satellites ($568) * Microwave ($316) * Fiber optics ($450) * Cellular radio ($93)
	Services ($91,141)	* voice ($82,809) * Data ($276) * Video ($8,051) * Radio ($5)
Information industry ($11,000)	Manufacturing ($5,600)	* Primary information producers ($4,700) * Secondary information producers ($900)
	Services ($5,400)	* Computer services ($2,600) * Support services ($2,100) * Seminars and conferences ($200) * Information retailing ($100) * On-line distributors ($400)
Knowledge industry ($80)	Manufacturing ($50)	* Expert systems ($50) * Knowledge-based systems ($25)
	services (30)	* Knowledge gateway systems ($5)
Total : 200 993		

Source : MARCHAND, D.A., HORTON, F.W., (1986, p. 30) as translated and presented in MARTIN, André, (1987, p.7).

Table 25

Comparison of Various Industrial Typologies

INDUSTRIES	MACHLUP APPROACH		OETTINGER	PORAT/OECD APPROACH			CANADA CONSULTING GROUP	MASUDA
	MACHLUP (1962)	RUBIN, HUBER, TAYLOR (1986)	(1980)	PORAT, RUBIN (1977)	OCDE (1981, 1986)	RUBIN, TAYLOR (1981)	(1984)	(1980)
I - PRIMARY								
- Inspection, testing and grading of agricultural products	-	-	-	-	X	-	-	-
- Fishery inspection services	-	-	-	-	X	-	-	-
- Grading and exploration services (mines and energy)	-	-	-	-	X	X	-	-
II - SECONDARY								
A) Manufacturing								
- Textile grading services	-	-	-	-	X	-	-	-
- Wallet manufacture	-	-	-	-	X	-	-	-
- Printing and publishing	X	X	Q[1]	Q[2]	X	Q[3]	X	X
- Photographic supplies/equipment	X	X	X	X	X	X	X	X
- Musical instruments	X	X	-	-	-	-	X	X
- Grading machinery (agricultural)	-	-	-	-	X	-	-	-
- Paper mill machinery	-	-	-	X	X	-	-	-
- Printing trade machinery	X	X	-	X	X	X	-	X
- Measuring and controlling equipment	X	X	-	X	X	X	X	Q[4]
- Office machines	X	X	X	X	X	X	X	X
- Electronic components	-	-	-	X	X	X	X	-
- Telecommunications and other electronic communications equip.	Q[5]	X	Q[6]	X	X	X	X	-
- Motion picture supplies/equipment	X	X	Q or X	X	X	X	X	X
- Radio and TV sets, phonographs	X	X	Q[7]	X	X	X	X	X
- Computers	X	X	X	X	X	X	X	X

Key: -: Excluded from the typology Q : Some restrictions X : All items are considered Q or X : Imprecise

[1] Except commercial printing and lithography; [2] Except lithographic platemaking, commercial engraving; [3] Except lithographic plate-making, commercial printing, engraving, lithographic and type press, various publications, envelopes; [4] Equipment used in R & D; [5] Not including satellites or electronic navigation and detection aids; [6] Not including electronic navigation or detection aids; [7] Only radio and TV sets considered.

Table 25

Comparison of Various Industrial Typologies
(cont.)

INDUSTRIES	MACHLUP APPROACH		OETTINGER	PORAT/OECD APPROACH			CANADA CONSULTING GROUP	MASUDA
	MACHLUP (1962)	RUBIN, HUBER, TAYLOR (1986)	(1980)	PORAT, RUBIN (1977)	OCDE (1981, 1986)	RUBIN, TAYLOR (1981)	(1984)	(1980)
- Professional and scientific equipment	X	X	-	X	X	X	X	Q[8]
- Manufacture of watches and clocks	-	X	-	X	X	X	-	-
- Inks and carbon black	-	-	-	X	X	-	-	-
- Office supplies	X	X	Q[9]	X	X	X	-	-
- Office furniture	-	-	-	X	X	X	-	-
B) Construction and maintenance (information buildings)	-	-	-	X	X	Q[10]	-	-
III - TERTIARY								
- Wholesale trade: information goods	Q	Q	-	X	X	Q or X	Q[11]	-
- Retail trade: information goods	-	-	-	X	X	Q or X	Q[12]	-
- Transportation and tourism								
. Railroad clearing houses	-	-	-	-	X	-	-	-
. Radar and flying control centres	-	-	-	-	X	-	-	-
. Inspection/tourist agencies	-	-	-	-	X	-	-	-
- Communications								
. Radio and television	X[13]	X	X	X	X	X	X	X
. Telephone and telegraph	X	X	X	X	X	X	X	-
. Postal services	X	X	X	X	X	X	X	-
- Conventions	X	X	-	-	-	-	-	-
- Cinema (production, distribution)	X	X	X	X	X	X	X	X
- Financial institutions								
. Banks	Q	Q	X	Q	X	X	X	-
. Credit agencies	Q	Q	X	Q	X	X	Q or X	-
. Security and commodity brokers	Q	Q	-	Q	X	Q	X	-
. Insurance	Q	Q	X	Q	Q	X	X	-
. Real estate services	Q	Q	X	Q	Q	Q	X	-
- Medical and hospital services	Q[14]	Q[15]	-	Q	Q	Q	-	-

Key: -: Excluded from the typology Q : Some restrictions X : All items are considered Q ou X : Imprecise

8 Equipment used in R&D; 9 Paper; 10 Construction of information buildings, without maintenance; 11 Electric and electronic machines, equipment and supplies; 12 Radio, TV, phono, bookstores; 13 Except cable TV and mobile radio; 14 Some doctors, but not dentists or surgeons; 15 Diagnosis and consultation only.

Table 25

Comparison of Variouss Industrial Typologies
(cont.)

INDUSTRIES	MACHLUP APPROACH		OETTINGER	PORAT/OECD APPROACH			CANADA CONSULTING GROUP	MASUDA
	MACHLUP (1962)	RUBIN, HUBER, TAYLOR (1986)	(1980)	PORAT, RUBIN (1977)	OCDE (1981, 1986)	RUBIN, TAYLOR (1981)	(1984)	(1980)
- Business Services								
. Advertising	X	X	X	X	X	X	X	X
. Legal services	X	X	X	X	X	X	X	X
. Accounting & management services	X	X	X	X	X	X	X	X
. Computer services	X	X	X	X	X	X	X	X
. Consulting engineers, architects	X	X	-	X	X	X	X	X
. Other business services	Q	Q[17]	Q[16]	Q[18]	X	Q	X	Q[19]
- Miscellaneous services								
. Repair and maintenance	Q[20]	Q[21]	-	Q[22]	Q[23]	Q[24]	-	-
. Photographic studios	-	-	-	X	X	X	-	-
- Recreational/entertainment	Q[25]	Q[27]	Q[26]	Q[28]	Q[29]	Q or X	-	Q[30]
- Education, R & D, libraries	X[31]	X	X	X	X	X	X	X
- Museums, art galleries, zoos	-	-	-	-	X	Q	Q[32]	-
- Business, professional, union, political and religious assoc.	-	-	-	X	-	Q or X	-	Q[33]
- Government (except national defence, education, post office)	X	X	X[34]	X	X	X	X	-

Key: -: Excluded from the typology Q : Some restrictions X : All items are considered Q ou X : Imprecise

[16] Data banks and public opinion pollers only; [17] Adds title abstract firms to Machlup's typology; [18] Except security services; [19] Data banks, surveys, investigators, most consultants; [20] Radio and television sets; [21] Radio and television sets; [22] Radio, TV, phonograph, computers, photographic equipment; [23] Radio, TV, phonographs, computers, photographic equipment, watches and clocks; [24] More than Porat and the OECD; [25] Sports, shows, concerts, etc; [26] Authors, writers, poets, sports; [27] All authors, writers, poets, concerts and sports; [28] Entertainers and artists, sports (except promotions and ticketing); [29] Includes entertainers, artists and writers, but not sports activities; [30] Theatre troupes, orchestras, promoters, singers and painters - but not sports activities; [31] The only one to include education outside academic institutions; [32] Except botanical gardens and zoos; [33] Philosophical and religious associations; [34] Except social services.

2. OCCUPATIONAL TYPOLOGIES OF INFORMATION AND COMPUTERIZATION ACTIVITIES: SELECTIVE OVERVIEW OF THE LITERATURE

This chapter focuses on occupational typologies. Two major approaches are distinguished. The first deals with studies about knowledge and information occupations: scholars and men of learning (Plato and Bell), knowledge professions (Machlup; Rubin, Huber and Taylor), information occupations (Porat, OECD and others) and information professionals (Gupta, Debons et al.). The second approach concerns professions involved in the computerization process, an area that appears to have been studied less often and more recently by researchers. Discussion will focus on the Agence de l'Informatique's analysis of computer professions, Roland Jouandet-Bernadat's study of telematics professions, as well as Raymond Panko's study of office occupations. Lastly, some of the typologies studied are compared.

2.1 Knowledge and Information Occupations

2.1.1 Research based on the Works of Plato: Scholars and Men of Learning

a) Plato (IVth century B.C.)

In The Republic, Socrates describes Plato's ideal city. Warriors (guardians) protect the city, farmers provide food for the citizens, masons build dwellings, artisans and workers produce other goods and philosophers or magistrates administer the city. At the time, this division of roles was promoted due to the need for maintaining a just and harmonious state and also because Socrate thought that the characteristics and temperaments suited to each role: philosophers or magistrates are wise, soldiers are physically strong, etc.

b) Daniel Bell (1976)

The post-industrial society described by Daniel Bell drew from this vision of scholars in power. The Platonic influence affected the author himself. He felt that recent so-called scientific industries (chemicals, pharmaceuticals, communications, aeronautics, electric and electronic equipment, scientific equipment, etc.), as well as the spread of applications evolving

from codified theoretical knowledge rather than empirical methods, were bringing us towards a new order, a world where scientists, professionals and technicians would play a central role. Although neither the relations are as clear nor the definitions as distinct as those of Plato, Daniel Bell saw the emergence of three major classes "the creative elite of scientists and top professional administrators [...] the middle class of engineers and the professorate, and the proletariat of technicians, junior faculty and teaching assistants." [1]

2.1.2 Research based on the Works of Machlup: Knowledge Occupations

a) Machlup (1962, 1975)

In 1962, Machlup presented the evolution of occupations in the United States from 1900 to 1959. Decennial censuses were used, as well as quarterly surveys for the year 1959[2]. Results were classified according to the typology of the 11 occupational subcategories used by the U.S. Bureau of the Census, themselves grouped into three categories:

- White-collar workers
  1. Professional, technical and kindred workers
  3. Managers, officials and proprietors (except farmers)
  4. Clerical and kindred workers
  5. Sales workers

- Manual and service workers
  6. Craftsmen, foremen and kindred workers
  7. Operatives and kindred workers
  8. Private household workers
  9. Service workers (except household)
  11. Labourers, except farm and mine

- Farm workers
  2. Farmers and farm managers
  10. Farm labourers and foremen

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[1] BELL, Daniel (1973, pp. 213-214).

[2] For 1900 to 1950 U.S. BUREAU OF THE CENSUS. Occupational Trends in the United States, 1900 - 1950, working paper no. 5. For 1959: U.S. BUREAU OF THE CENSUS. Current Population Reports, series P-60, No. 33.

During this period, there was a substantial increase in white collar professions. Machlup noted, however, that not all of them could be viewed as knowledge occupations. He made adjustments (exclusions and inclusions) extending beyond the strict confines of scholarly professions:

> "I define a knowledge occupation as one that involves activities, gainful or costly, that are designed chiefly to aid in the generation, transmission, or reception of knowledge of any type, sort or quality, including giving, directly or through instruments, visual, aural, or otherwise sensible signals, and ranging from carrying messages to creating new knowledge."[1]

Whereas his industrial typology selected activities according to the nature of their output - no matter what the input - the occupational typology (Table 26) focused on the type of work done as input, no matter what the output produced by the establishment, firm or industry. Machlup concentrated therefore on knowledge-producing workers. For their part, knowledge users were considered only when their product was a communications product or contributed to its transmission. The worker's output had to be a message, "a piece of information, anything primarily designed to create an impression in someone's mind [...] even if their own mental equipment is relatively poor"[2]. Thus postmen and insurance agents were considered, unlike dentists and veterinarians, in all likelihood more "learned". More specifically, the following occupations were selected by Machlup based on U.S. Bureau of the Census classifications.

Occupations not included are presented in Table 27. They are found for the most part in the fields of health, retail trade, repair services and in blue collar trades as a whole (except for printing and publishing trades).

This typology enabled Machlup to estimate the following results. Knowledge-producing occupations went from 10.7% of the U.S. active civilian population in 1900 to 31.6% in 1959. Note that the author felt that students of working age also qualified, as they are involved in the production of human information capital, i.e. their own learning. The addition of full-time students from Grade 9 towards the economically active civilian labour force gave rise to

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[1] MACHLUP, F. (1980, pp. 228-229).

[2] MACHLUP, F. (1962, p. 383).

Table 26

Machlup (1962) : Typology of Knowledge Occupations*

Professional, technical and kindred workers

000	Accountants and auditors
001	Actors and actresses
002	Airplane pilots and navigators
003	Architects
004	Artists and art teachers (includes decorators)
005	Athletes
006	Authors
007	Chemists
009	Clergymen
010	College presidents and deans
012	Professors and instructors, agricultural sciences
013	Professors and instructors, biological sciences
014	Professors and instructors, chemistry
015	Professors and instructors, economics
016	Professors and instructors, engineering
017	Professors and instructors, geology and geophysics
018	Professors and instructors, mathematics
019	Professors and instructors, medical sciences
023	Professors and instructors, physics
024	Professors and instructors, psychology
025	Professors and instructors, statistics
026	Professors and instructors, natural sciences (n.e.c.)
027	Professors and instructors, social sciences (n.e.c.)
028	Professors and instructors, nonscientific subjects
029	Professors and instructors, subject not specified
031	Dancers and dancing teachers
033	Designers
034	Dietitians and nutritionists
035	Draftmen
036	Editors and reporters (includes public relations people)
041	Engineers, aeronautical
042	Engineers, chemical
043	Engineers, civil
044	Engineers, electrical
045	Engineers, industrial
046	Engineers, mechanical
047	Engineers, metallurgical, and metallurgists
048	Engineers, mining
049	Engineers (n.e.c.)
051	Entertainers (n.e.c.)
052	Farm and home management advisors
053	Foresters and conservationists
055	Lawyers and judges
056	Librarians
057	Musicians and music teachers
061	Agricultural scientists
062	Biological scientists
063	Geologists and geophysicists
067	Mathematicians
068	Physicists
069	Miscellaneous natural scientists
070	Optometrists

* The codes are those of the U.S. Department of Commerce (Bureau of the Census). Classified Index of Occupations and Industries, 1950 Census of Population, Washington, D.C., 1950.

Table 26

Machlup (1962) : Typology of Knowledge Occupations*
(cont.)

Professional, technical and kindred workers (suite)	
072	Personnel and labor relations workers
074	Photographers
071, 075	Physicians and surgeons, osteopaths (50%)[1]
076	Radio operators (includes air trafic controls)
077	Recreation and group workers
078	Religious workers
079	Social and welfare workers, except group
081	Economists
082	Psychologists
083	Statisticians and actuaries
084	Miscellaneous social scientists
091	Sports instructors and officials
092	Surveyors
093	Teachers (n.e.c.)
095	Technicians testing (includes radio and tv announcers)
096	Technicians (n.e.c.)[4]
099	Professionnal, technical, and kindred workers (n.e.c.)[3]
Managers, officials, and proprietors, except farm	
200	Buyers and department heads, store[2]
201	Buyers and shippers, farm products[2]
204	Credit men
210	Inspectors, public administration
230	Managers and surintendents, building
240	Officers, pilots, pursers, and engineers, ship[2]
250	Officials and administrators (n.e.c.), public administration
260	Officials, lodge, society, union, etc.
270	Postmasters
280	Purchasing agents and buyers (n.e.c.)[2]
290	Managers, officials and proprietors (n.e.c.)[2]

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1 We presume that osteopathe are included with doctors.

2 Except management personnel (salaried and self-employed) in retail trade and occupations involved in repairs and/or working in garages.

3 Including systems engineers in industries manufacturing office machines.

4 Including computer technicians, technicians in the physical sciences, the audio-visual sector and television camera operators.

Table 26

Machlup (1962) : Typology of Knowledge Occupations*
(cont.)

Clerical and kindred workers	
300	Agents (n.e.c.)
301	Attendants and assistants, library
302	Attendants, physicians and dentists' office
304	Baggagemen, transportation
305	Bank tellers
310	Bookkeepers
320	Cashiers
321	Collectors, bill and account
322	Dispatchers and starters, vehicle
325	Express messengers and railway mail clerks
335	Mail carriers
340	Messengers and office boys
341	Office machine operators
342	Shipping and receiving clerks
350	Stenographers, typists, and secretaries
360	Telegraph messengers
365	Telegraph operators
370	Telephone operators
380	Ticket, station, and express agents
390	Clerical and kindred workers (n.e.c.)
Sales workers	
400	Advertising agents and salesmen[5]
410	Auctionners[5]
420	Demonstrators[5]
450	Insurance agents and brokers[5]
470	Real estate agents and borkers[5]
480	Stock and bond salesmen[3]
490	Salesmen and sales clerks (n.e.c.)[3]
460	Newsboys
Craftsmen, foremen and kindred workers[6]	
502	Bookbinders
512	Compositors and typesetters
520	Electrotypers and stereotypers
521	Engravers, except photoengravers
571	Photoengravers and lithographers
575	Pressmen and plate printers, printing

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3 Including systems engineers in industries manufacturing office machines.

5 Except occupations involved in retail trade.

6 Chiefly these activities.

Table 27

Machlup (1962): Occupations not Included

Professionals, Technicians and Related Workers

- Chiropractors
- Dentists
- Morticians and embalmers
- Nurses
- Pharmacists
- 50 % of doctors and surgeons[1]
- All medical, oral hygiene and health examination technicians
- Therapists (physiotherapists, inhalation therapists, etc.)
- Veterinarians

Administrators, Civil Servants and Entrepreneurs (except Farmers)

- Train conductors
- All management personnel (salaried or self-employed) in retail trade
- Occupations involved in car repair or working in garages
- Occupations involved in various repairs[2]

Office and Related Workers

(nil)

Sales Workers

- Peddlers, salesmen and all other occupations involved in retail trade[3]

Workers, Foremen and Related Workers

- All excluded except for printing occupations, specifically typographers, stereotypers, photoengravers, lithogrophers, compositors, printing press operators, printers and engravers

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1 Based on the hypothesis that half their work is devoted to diagnosis, therapy and prescriptions.

2 They spend more time "physically" working in their workshops than working at administrative tasks.

3 Morel specialized in handling merchandise than in promotion and sales as such.

the concept of the potentially active civilian labour force. In 1900, knowledge-producing occupations, including wage-earning students and unemployed workers with previous experience, accounted for 13.5% of this potential active civilian population. In 1959, they accounted for 42.8%. In 1975, Machlup updated this data. Knowledge-producing professions had reached 39.7% of the active civilian labour force[1].

b) Rubin, Huber and Taylor (1986)

After 1975, Machlup became involved in an extensive research program, with plans for 10 volumes on knowledge activities. Work on the project was interrupted at the fourth volume when he died. The last volume of the series would have dealt with knowledge occupations. His research assistant, Mary Huber, then began working with Michael Rubin and Elizabeth Taylor. Together they synthesized and updated Machlup's approach[2]. As is the case with any analysis of occupations and employment over long periods, a number of problems arose: definitions of manpower fluctuated over time; new occupations appeared while others disappeared; and government systems of classifying data often varied from one census to another. Nonetheless, the authors attempted to respect Machlup's approach as much as possible.

They employed, however, a broader concept of the economically active civilian labour force. The requirement for previous experience in the field in which an unemployed worker was seeking employment was removed, and graduates of academic institutions were included in this grouping. Keep in mind that in Machlup's first report on the matter, the unemployed without previous experience were not considered.

From 1960 to 1980, knowledge professions went from 31.19% to 41.3% of the economically active civilian labour force. If full-time students (Grade 9 and up) are added to this category, knowledge-related employment amounted to 53.26% of the potentially active civilian labour force in 1980, compared to 42.10% in 1960. The authors were more specific about Machlup's concept of a potentially active civilian labour force: "potentially" indicates a maximum

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1 MACHLUP, F. and KRONWINKLER, T. Workers who Produce Knowledge a Steady Increase", 1900 to 1970, 1975, as cited by SCHMORANZ, I. (1980, p. 137).

2 RUBIN, M.R., M.T. HUBER and E.L TAYLOR (1986).

number of students who could become knowledge producers. Once on the labour market, however, not all of them will become knowledge producers.

2.1.3 Research based on Porat and the OECD: Information Occupations

a) Porat and associates (1974-1977)

In 1974, Edwin Parker and Marc Uri Porat identified the information occupations[1]. The idea was further developed in Porat's 1976 thesis. In 1977, Porat published a major work on the subject for the U.S. Department of Commerce. A typology of information occupations was proposed and then, with the help of Rubin, evaluated[2].

Table 28 presents occupations that are "primarily engaged in the production, processing, or distribution of information as output, and which occupations perform information processing tasks as activities ancillary to the primary function"[3].

The first category lists professions for which the output produced, or most of the output, is an information good or service sold on the market. This includes knowledge producers (scientists and technicians, lawyers, architects, accountants, programmers, etc.) and knowledge distributors (teachers, archivists, librarians, writers, photographers, authors, radio and television announcers, etc.).

The second category involves workers who research and disseminate information within firms and on the market. These are occupations involved in gathering information on-site (inspectors, appraisers, interviewers, etc.), those who deal in market exchange (buyers, sellers, brokers), planning and control (managers, controllers, supervisors, etc.) and those who process information (secretaries, clerks, cashiers, etc.). The third category includes occupations involved in operating information equipment and machines: operators, printers, stenographers, repair personnel, etc. They provide support for the first two categories.

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1 PARKER, Edwin and Marc Uri PORAT (1974).

2 PORAT, Marc Uri and Michael RUBIN (1977).

3 PORAT and RUBIN (1977, vol. 1, p. 105).

Table 28

Porat (1977) : Typology of Information Occupations

1. Professions for which information is sold on the marketplace

A) Knowledge Producers

Scientific and Technical Workers

- Natural & Technical workers:
  - Agricultural Scientists
  - Atmosphere, Space Scientists
  - Biological Scientists
  - Chemists
  - Geologists
  - Marine Scientists
  - Physicists and Astronomers
  - Life, Physical Scientists
- Mathematical Sciences:
  - Mathematicians
  - Statisticians
  - Operations, System Research
  - Research Workers
- Social Sciences:
  - Economists
  - Political Scientists
  - Psychologists
  - Sociologists
  - Urban & Regional Planners
  - Other Social Scientists
- Engineering:
  - Engineers, Aero-Astronautic
  - Engineers, Chemical
  - Engineers, Civil
  - Engineers, Electrical
  - Engineers, Industrial
  - Engineers, Mechanical
  - Engineers, Metallurgical
  - Engineers, Mining
  - Engineers, Petroleum
  - Engineers, Sales
  - Engineers, Other

Private Information Service Providers

- Conselors and Advisors:
  - Lawyers and Judges
  - Farm Managers & Advisors
  - Foresters, Conservationists
  - Home Management Advisors
  - Vocational, Education Counselors
  - Personnel Labor Relations
  - Architects
  - Therapists
  - Dietitians
  - Physicians (50%)
  - Designers
  - Draftmen
  - Social Workers
- Computer specialists:
  - Computer Programmers
  - Other Computer Specialists
  - Computer Systems Analysts
  - Numerical Tool Programmers
- Financial Specialists:
  - Accountants
  - Bank, Financial Managers
  - Creditmen
  - Actuaries

B) Knowledge Distributors

Educators

- Adult Education Teachers
- Agriculture Teachers
- Art, Drama, Music Teachers
- Atmospheric, Earth Marine Teachers
- Biology Teachers
- Business, Commerce Teachers
- Chemistry Teachers
- Economic Teachers
- Education Teachers
- Elementary School Teachers
- Engineering Teachers
- English Teachers
- Foreign Language Teachers
- Health Specialties Teachers
- History Teachers
- Home Economics Teachers
- Law Teachers
- Mathematics Teachers
- Physics Teachers
- Preschool, Kindergarten Teachers
- Psychology Teachers
- Secondary School Teachers
- Sociology Teachers
- Social Science Teachers
- Miscellaneous College & University Teachers
- College, University (n.e.c.)
- Theology Teachers
- Trade, Industrial Teachers
- Teachers, Exc. College, University
- Teachers Aides, Exc. Monitors
- Coaches, Phys Ed Teachers (50%)

Public Information Disseminators

- Librarians
- Archivists and Curators
- Library Attendants, Assistants

Communication Workers

- Writers, Artists, Entertainers:
  - Editors and Reporters
  - Photographers
  - Authors
  - Public Relations People, Writers
  - Radio, TV Announcers

Table 28
Porat (1977) : Typology of Information Occupations
(cont.)

2. Professions for which information is not sold on the marketplace

A) Co-ordinating Specialists and Market Analysts marches

Information Gatherers:

Enumerators and Interviewers
Estimators, Investigators
Inspectors, Exc. Construction, Public Assess, Control, Local Public Administration
Construction Inspectors, Public
Real Estate Appraisers
Insurance Adjusters, Exam.
Meter Readers, Utilities
Weighers
Surveyors
Bill Collectors

Search and Coordination Specialists

- Buy Side:

Buyers, Shippers, Farm Prod.
Buyers, Wholesale, Retail
Purchasing Agents, Buyers

- Brokers:

Insurance Agents, Brokers, etc.
Real Estate Agents, Brokers
Stock and Bond Salesmen
Auctioneers

- Sell Side:

Advertising Agents, Salesmen
Sales Representatives, Manufacturing
Sales Representatives, Wholesale Trade
Sales Manager, Retail Trade
Sales Manager, Exc. Retail Trade
Demonstrators
Salesmen, Retail (50%)
Salesmen, Services (50%)

Planning and Control Workers

- Administrators and Managers:

Officials, Administrators, Public
School Administrators, College
School, Admin., Elementary & Secondary
Office Managers
Other Managers, Administrators
Foremen (50%)
Officer, Ship (50%)

- Process Control Workers:

Clerical Supervisors
Postmasters and Mail Superintendents
Health Administrators
Expeditors, Production Controllers
Air Traffic Controllers
Payroll, Time Keeping Clerks

B) Information Processing Specialists

Non-Electronic Based*

Proofreaders
Secretaries, Legal
Secretaries, Medical
Secretaries, Other
File clerks
Postal Clerks
Motion Picture Projectionnists
Newsboys
Mail Carriers, Post Office
Mail Handler, Exc. Post Office
Messengers and Office Boys
Telegraph Messengers
Shipping, Receiving Clerks
Statistical Clerks
Health Record Technologist
Clerical Asst., Social Welfare
Inspectors, Log and Lumber
Inspectors, Other
Checkers, Examinors, etc.
Receptionists (50%)
Miscellaneous Clerical
Railroad Conductors (50%)

Electronic Based*

Bank Tellers
Billing Clerks
Bookkeepers
Cashiers
Typists
Ticket Station, Express Agents
Sales Clerks, Retail Trade (50%)
Registered Nurses (50%)
Radiology Technical (50%)"

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* The last Census Handbook of Occupational Titles describes which occupations are electronic-based. This table reflects the expected changes in classifications based on 1980 technology.

Table 28

Porat (1977) : Typology of Information Occupations
(cont.)

3. Information Infrastructure Professions

Non-Electronic Machine Operators

Stenographers
Duplicating Machine Operators
Other Office Machine Operators
Bookbinders
Compositors and Typesetters
Electrotypers, Stereotypers
Engravers, Exc. Photoengravers
Photoengravers, Lithographers
Pressmen and Plate Printers
Pressmen Apprentices
Printing Apprentices, Exc. Press
Photographic Process Workers
Sign Painters

Electronic Machine Operators

Bookkeeping, Billing Operators
Calculating Machine Operators
Computer, Peripheral Equipment Operators
Keypunch Operators
Tabulating Machine Operators
Data Processing Machine Repair
Office Machine Repairmen

Telecommunications Workers

Telegraph Operators
Telephone Operators
Telephone Installers, Repairmen
Telephone Linemen, Splicers
Radio Operators
Radio, Television Repairmen

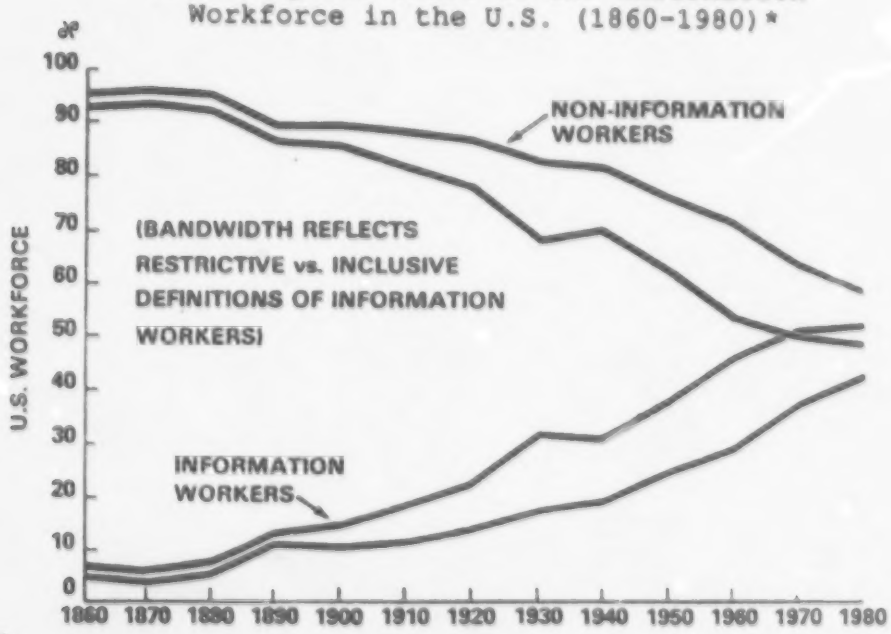
Source: PORAT, M.U. and M. RUBIN (1977, volume 1, pp. 112-114).

For approximately 28 professions, Porat found it difficult to determine the dominance of one sort of task over another (information and non-information tasks) in the day-to-day performance of duties. In his inclusive definition of occupations, Porat integrated half the occupations connected with these professions, presupposing that these workers spent 50% of their time on information tasks. In his restrictive definition, these professions all belong in non-information fields. Table 29 lists these problem cases.

Figure III illustrates the results obtained. The growth of information employment in the United States is presented according to inclusive and restrictive definitions. Accounting for less than 10% of labour in 1860, information occupations represented more than 50% around 1970 (inclusive version). Porat later adjusted this estimate. In 1983, 56% of the active labour force was involved, i.e. 54 million Americans[1].

Figure III

Chronological Chart of the Information Workforce in the U.S. (1860-1980)*



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* U.S. Bureau of Labor Statistics projections.
Source: PORAT, M.U. (1977, vol. 1, p. 120).

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[1] PORAT (1984).

Table 29

Porat (1977) : Occupations with Ambiguous Status

Physicians	Inspectors (n.e.c.)
Registered Nurses	Chainmen, Rodmen (Surveying)
Dietititians	Checkers, Examiner, Inspectors (Manufac.)
Clinical Lab technologists	Graders and Sorters (Manufacturing)
Health Record Technologists	Hucksters
Radiological technologists	Sales Clerks, Retail Trades
Designers	Misc. Clerical Workers
Counter Clerks, Exc. Food	Managers, Retail Trade, Salary
Officers, Pilots, Pursers on Ships	Managers, Retail Trade, Self-Employed
Officials of Lodges, Societies, Unions	Managers, Personal Services, Salaried
Railroad conductors	Managers, Personal Services, Self-Employed
Demonstrators	Managers, Business Services, Salaried
Foremen (n.e.c.)*	Managers, Bus. and Repair Serv., Self-Emp.
Inspectors, Scalers, Graders, Lumber	Receptionists

* Foremen used to work on machines alongside craftmen. However, with the advent of unions, foremen were increasingly relegated to nonproduction jobs such as scheduling, inventory control, and on-the-job training. They are now a "buffer" between the productive workers and the managers, and are often specifically barred from working on machines for fear of breaking union rules. Similarly, inspectors, checkers, and the like often work in industrial settings but most of their time is spent gathering information about a production process.

Source: PORAT, M.U. and M. RUBIN (1977, volume 1, p. 119).

The occupational typologies of Machlup, Porat and Rubin concur on a number of points. The professional, technical and kindred workers category, however, contains many differences (Table 30). Both typologies excluded morticians and managers of restaurants, cafeterias and bars from the managers, officials and proprietors category. Machlup, however, excluded all management personnel involved in retail trade or repair services. In his inclusive definition, Porat took these professions into consideration, as well as others ignored by his predecessor:

- managers, retail trade, salaried	(50 %)
- managers, retail trade, self-employed	(50 %)
- managers, personal services, salaried	(50 %)
- managers, personal services, self-employed	(50 %)
- managers, business services, salaried	(50 %)
- managers, business services, self-employed	(50 %)
- railroad conductors	(50 %)
- officers, pilots, pursers and engineers, ship	(50 %)[1]

Machlup continued along the same vein for sales workers. Not all retail trade professions were necessarily included. Porat included almost all sales occupations in his inclusive definition. Only "hucksters and peddlers", "sales clerks, retail trades" and "demonstrators" were considered, at a rate of 50%. These three categories are excluded in the restrictive definition.

Professions grouped under clerical and kindred workers were not exactly the same as those analyzed by Machlup (1957) and Porat (1967). The U.S. Bureau of the Census has made several adjustments over the years to its occupational classification, mainly because of the changes that have occurred in offices regarding the nature of tasks and the organization of work. Machlup included all the occupations listed in the category of the time, while Porat later included virtually the entire category.

The occupations of receptionists, misc. clerical workers and counter clerks (except food) were taken into consideration only in the inclusive definition (50%), while stock clerks and storekeepers were absent from both. Under office machine operators in Machlup's typology, Porat added computer and peripheral equipment operators, of which there were very few in the late 1950s.

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[1] Machlup excluded all workers involved mainly in repair work.

Table 30

Comparison of the Typologies of Machlup and Porat regarding Professional Occupations and Technicians

1) Professions added compared to Machlup's Typology

- Health:
  - Radiologic technologist and technicians (50% inclusive def.)
  - Therapy assistants
  - Health technologists & technicians, n.e.c. (50% inclusive def.)
  - Registered nurses (50 % inclusive def.)
  - Clinical laboratory technologists and technicians (50% inclusive def.)
- Operations and systems researchers and analysts (although Machlup included systems engineeers under 099)
- Computer specialists (more fully developed by Porat. Machlup listed only computers technicians in the oil and gas industry under 099 and computer-geodetic survey under 092 surveyors).

2) Professions deleted compared to Machlup's Typology

- Interprets and traductors (under 099 professional, technical (n.e.c.)
- Decorators (except glass products, which are listed under painters and sculpters)
- Airplane pilots (50% inclusive def.)
- Clergymen
- Religious workers
- Optometrists
- Dietetetians and nutritionists (50% inclusive def.)
- Recreation and group workers
- Coaches and physical education teachers (50% inclusive def.)
- Artists and entertainers:
  - Actors and actresses
  - Athletes & kindred workers
  - Dancers
  - Designers (50% inclusive def.)
  - Musicians and composers
  - Artists

Regarding craftsmen and kindred workers, Machlup focused exclusively on professions related to printing and publishing. Porat extended his typology to include:

- Telephone installers and repairmen
- Telephone linemen and splicers
  Mechanics and repairmen:
  . Data processing machines
  . Office machines
  . Radio and television sets
- Sign and letter painters
- Motion picture projectionists
- Inspectors, scalers, graders, log and lumber (50 % inclusive definition)
- Inspectors, n.e.c. (50 % inclusive definition)
- Foremen (50 % inclusive definition)

Porat also drew on certain occupations he listed under operatives, except transport:

- Photographic process workers
- Chainmen, rodmen (surveying) (50 % inclusive definition)
- Checkers, examiners, inspectors (manufacturing) (50 % inclusive definition)
- Graders and sorters (manufacturing) (50 % inclusive definition)

Machlup ignored this professional category. Unlike Porat, however, he included baggagemen (transportation), previously listed under clerical and kindred workers and later under service workers (except private household).

Porat's occupational typology was definitely more extensive than Machlup's. This is most evident as regards health professionals, retail trade managers, repair workers, labourers, and inspectors and foremen (manufacturing). His restrictive definition brought him closer to Machlup, who differed from Porat by including professions in the fields of religion, entertainment and recreation (musicians, actors, dancers, athletes, etc.).

b) The OECD (1981, 1986)

In 1981 the OECD published data on the information professions as a percentage of the economically active population in various countries Austria (1951, 1961, 1971, 1975), Canada (1951, 1961, 1971), Finland (1950, 1960, 1970, 1975), France (1954, 1962, 1968,

1975), Japan (1960, 1965, 1970, 1975), Sweden (1960, 1965, 1970, 1975), the United Kingdom (1951, 1961, 1971), the United States (1950, 1960, 1970) and West Germany (1950, 1961, 1970, 1976, 1978). In 1986, the OECD added estimates for Australia (1971, 1981), Denmark (1980), Finland (1980), West Germany (1980, 1982), New Zealand (1975, 1981), Norway (1975, 1981), Sweden (1980), the United Kingdom (1981) and the United States (1980). Table 31 presents some of the results. Note that the phenomenon varies considerably from one country to the next.

The federal Department of Communications participated in the OECD's 1981 study. Shirley Serafini and Michel Andrieu (1980) presented the Canadian results according to the groups and sub-groups used by the OECD and later by Rubin and Sapp (1981). Decennial censuses were used. From 1931 to 1971, the portion of information professions in Canada went from 21% to 39.9%. In 1971, 63% of this workforce dealt with information processing, i.e. one-quarter of the economically active Canadian labour force[1].

The OECD typology distinguished four major categories of information occupations (Table 32). Information Producers includes scientific and technical personnel, market search and co-ordination specialists (brokers, buyers, salesmen, etc.), information gatherers (inspectors, testers, surveyors), consultants (decorators, lawyers, accountants, programmers, optometrists, doctors, etc.) and other information producers (authors and composers). Information Processors includes administrative and managerial personnel, control and supervisory personnel and clerical personnel (clerks, secretaries, etc.). The Information Distributors category focuses exclusively on educators and communications workers (journalists, stage directors, producers, announcers, etc.). The last category, Information Infrastructure Occupations, has two sections: information machine workers (photographers, printers, etc.) and postal and telecommunications workers (postmen, telephone operators, repairmen, etc.).

Unlike Porat, the OECD did not classify information occupations according to whether or not they gave rise to output sold on the market. The other groupings are fairly close to Porat's (Table 33). Administrative and other managerial personnel, control and supervisory personnel, as well as clerical personnel, are listed under "information processors", unlike Porat's classification.

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[1] In 1986, the federal Department of Communications estimated information occupations at 45% of the labour force. DEPARTMENT OF COMMUNICATIONS (1987, p. 14).

Table 31

OECD (1981, 1986): Composition of the Information Labour Force
(percentage of economically active)

	Australia 1971	1981	Austria 1951	1971	Canada 1951	1971	Finland 1970	1980	France 1954	1975	West Germany 1950	1980	1982	Japan 1960	1975	N.-Zealand 1976	1981	Norway 1975	1981	Sweden 1960	1980	U.K. 1951	1971	1981	U.S. 1950	1978	1980	Average Quinquennial Change*	
INFORMATION SERVICES	5,2	6,4	3,3	5,1	4,4	7,6	3,3	4,7	3,6	6,4	3,1	6,5	6,9	2,1	4,5	6,6	7,0	5,1	5,4	2,5	5,6	3,9	5,0	8,8	5,0	7,2	9,7	+ 0,68	(0,60)
Scientific and Technical	0,8	1,6	0,4	0,4	2,6	5,3	1,2	1,9	0,6	1,5		1,7	1,7	0,6	1,0	1,9	1,8			0,4	0,8	0,5	1,4	2,0	1,3	2,1	2,1	+ 0,17	(0,14)
Consultative Services	2,4	3,0	0,9	1,6			1,3	1,7	1,8	3,0		2,4	2,7	0,5	1,1	2,9	2,9			0,5	1,4	1,1	1,5	3,3	1,9	2,7	3,9	+ 0,27	(0,20)
Information Gatherers	0,3	0,2	0,6	1,2	0,8	1,1	0,1	0,2	0,3	0,5		0,3	0,3			0,3	0,4			0,1	0,2	1,0	0,9	1,3	0,3	0,3	0,4	+ 0,05	(0,05)
Market Search and Co-ordination Specialists	1,7	1,6	1,4	1,9	1,0	1,2	0,7	0,9	0,9	1,6		2,1	2,2	1,0	2,4	1,5	1,9			1,5	3,2	1,3	1,2	2,3	1,5	2,1	3,3	+ 0,21	(0,18)
INFORMATION PROCESSING	26,7	27,1	10,7	17,8	20,1	25,2	12,7	18,1	13,4	19,7	11,2	19,6	10,3	12,3	20,6	25,7	25,6	10,2	10,8	17,0	21,2	18,3	23,5	24,1	21,2	26,5	28,6	+ 1,36	(1,65)
Administrative and Managerial	12,4	11,4	4,8	7,7	10,4	12,3	5,1	7,9	6,3	6,7		4,1	4,8	2,3	4,4	11,3	11,6			3,1	3,2	4,5	6,6	7,0	8,6	8,1	11,5		
Process Control and Supervisory									1,5	3,2		1,1	1,1			2,6	2,8			6,0	7,5	3,2	3,7	3,6	1,4	2,0	4,0	+ 0,60	(0,54)
Clerical and Related	14,3	15,7	5,9	10,1	9,7	12,9	7,6	10,2	5,6	9,8		14,4	14,4	10,0	16,2	11,8	11,2			7,9	10,7	10,6	13,2	13,5	11,2	16,4	13,1	+ 0,79	(1,08)
INFORMATION DISSEMINATION	3,4	4,7	1,6	2,1	2,-	4,7	3,1	3,8	1,9	3,9	1,1	2,8	3,0	1,9	2,4	4,0	4,1	4,5	5,1	2,5	5,3	2,0	3,2	4,3	2,3	4,0	4,6	+ 0,38	(0,36)
Educators	2,9	4,0	1,6	1,9	2,1	3,9	2,8	3,4	1,6	3,7		2,7	2,9	1,8	2,2	3,6	3,4			2,3	4,9	1,7	2,9	3,9	2,1	3,8	4,2	+ 0,36	(0,35)
Communication Work.	0,5	0,7	0,2	0,2	0,4	0,8	0,3	0,4	0,3	0,2		0,1	0,1	0,1	0,2	0,4	0,7	1,0	1,6	0,2	0,4	0,3	0,3	0,4	0,2	0,2	0,2	+ 0,04	(0,02)
INFORMATION MACHINERY	4,1	3,3	2,2	3,0	2,3	2,4	3,0	3,5	1,4	2,1	2,9	4,6	4,6	1,6	2,1	3,1	3,1			3,9	4,0	2,5	3,9	3,6	2,2	3,4	3,1	+ 0,14	(0,26)
Information Machine Workers	2,3	2,9	0,7	1,2	0,9	1,3	1,3	1,7	0,6	0,7		3,8	3,7	1,0	1,4	2,2	2,1			1,3	1,8	1,4	2,3	1,7	1,0	2,3	1,7	+ 0,10	(0,14)
Postal and telecommunications	1,8	1,4	1,3	1,8	1,4	1,1	1,7	1,8	0,8	1,4		0,8	0,9	0,6	0,7	0,9	1,0			2,6	2,6	1,1	1,0	2,0	1,2	1,1	1,4	+ 0,06	(0,05)
TOTAL	39,4	41,5	18,0	28,0	29,3	39,9	22,1	30,1	20,3	32,1	18,3	33,5	34,8	17,9	29,6	39,4	39,8	20,8	22,9	25,9	36,1	26,7	35,6	41,0	30,7	41,1	45,8	2,58	(2,83)

* Note that the component in this column do not always sum to their main group totals. This is due to the fact that in obtaining an average of quinquennial change for each component we have a less complete data set than for each main group.

Source: OECD (1986, pp. 10-11).

Table 32

OCDE (1981, 1986) : Information Professions*

I - INFORMATION PRODUCERS

1. Scientific and Technical Personnel

0-11 Chimists
0-12 Physicists not elsewhere classified
0-13 Physical scientists not elsewhere classified
0-22 Civil Engineers
0-23 Electrical and Electronic Engineers
0-24 Mechanical Engineers
0-26 Metallurgists
0-27 Mining Engineers
0-28 Industrial Engineers (except 0-28,30)
0-29 Engineeers, not elsewhere classified
0-51 Biologists, zoologists and related
0-52 Bacteriologists, pharmacologists
0-53 Agronomists and related
0-81 Statisticians
0-82 Mathematicians and Actuaries
0-90 Economists
1-92 Sociologists, Anthropologists and related

2. Market Search and Co-ordination Specialists

4-10.20 Commodity Brokers
4-22 Purchasing Agents and Buyers
4-31 Technical Salesmen and Advisors
4-41 Insurance and Stock Agents, Brokers and Jobbers
4-42 Business Services/Advertising Salesmen
4-43.20 Auctioneers

3. Information Gatherers

0-28.30 Workstudy Officers
0-31 Surveyors (land, mine, hydrographic, etc.)

1-39.50, 7-54.70, 3-59.30, 8-59.20, 3-59.45, 9-49.80, 3-91.50, 5-81.20 | Inspectors, Viewers and Testers (various)

3-91.50 5-89.20 Information Gatherers not elsewhere classified
0-33.20 Surveyors
4-43.30 Estimators

4. Consultative Services

0-21 Architects and Town Planner
0-32 Draughtsmen
0-61 Medical Practitioners
0-69 Dieticians and Nutritionists
0-75.20 Optometrists
0-83 System Analysts
0-84.20 Computer Programmers
1-10 Accountants (except 1-10.20)
1-21, 1-29 | Barristers, Advocates and Solicitors, etc.
1-39.20 Education Meethods Advisors
1-62 Commercial Artists and Designers

* The codes used are International Standard Industry Classification (ISIC) codes, revised 1968, International Labour Office, Geneva. This work encompasses 284 basic groups incorporating 1,506 professional categories.

Table 32

OCDE (1981, 1986) : Information Professions (cont.)

5. Information Producers not elsewhere classified

1-51.20 Authors
1-71.20 Composers

II - INFORMATION PROCESSORS

1. Administrative and Managerial

1-22 Judges
1-39.40 Head Teachers
2-01 Legislative Officials
2-02 Government Administrators
2-11 General Managers
2-12 Production Managers
2-19 Managers (n.e.c.)
3-10 Government Executive Officials
4-00 Managers (Wholesale/Retail Trade)

2. Process Control and Supervisory

0-33.40 Clerk of Works
0-41.40 | Flight and Ship Navigation
0-42.30 | Officers
3-5 Transport and Communications Supervisors (except 3.59.30 and 3-59.45)
3-91.20 Dispatching/Receiving Clerks

3-0 5-20 6-00.30 | Supervisors:
4-21 5-31.20 6-32.20 | Clerical, Sales and Other
7-0 Supervisors and General Foremen

3. Clerical and Related

1-10.20 Auditors
3-21 Stenographers, Typists and teletypists (except 3.21.50)
3-31.10 Bookkeepers (general)
3-31.20 Bookkeepers (clerks)
3-39.20 Cost Computing Clerks
3-39.30 Wages Clerks
3-39.40 Bank and Financial Clerks
3-91.30 Stock Records Clerks
3-92.20 | Material and Production Planning
3-92.30 | Clerks
3-93 Correspondence and Reporting Clerks
3-94 Receptionists and Travel Agency Clerks
3-95 Library and Filing Clerks
3-99.20 Statistical Clerks
3-99.30 Coding Clerks
3-99.40 Proof Readers

III - INFORMATION DISTRIBUTORS

1. Educators

1-31 University and Higher Education Teachers
1-32 Secondary Teachers
1-33 Primary Teachers
1-34 Pre-primary Teachers
1-35 Special Education Teachers

Table 32

OCDE (1981, 1986) : Information Professions (cont.)

2. Communication Workers

1-51.30 et 1-59 Journalists and related Writers (except 1-59.55)
1-73.30 Stage Directors
1-73.40 Motion Picture, Radio and Television Directors
1-73.50 Storytellers
1-74 Producers, Performing Art
1-79.20 Radio, Television Announcers

IV - INFORMATION INFRASTRUCTURE OCCUPATIONS

1. Information Machine Workers

1-63 Photographers and Cameramen
3-21.50 Teleprinter Operators
3-22 Card and Tape-punching Machine Operators
3-41 Bookkeeping and Calculating Machine Operators
3-42 Automatic Data-Processing Machine Operators
3-99.50 Office Machine Operators
8-49.65 Office Machine Repairmen
8-62 Audio-Visual Equipment Operators
9-21 Compositors and Type-setters
9-22 Printing Pressmen (except 9-22.70)
9-23 Stereotypers and Electrotypers
9-24 Printing Engravers (except 9-24.15 and 9-24.30)
9-25 Photo-engravers
9-26 Bookbinders and related
9-27 Photographic Processors

2. Postal and Telecommunications

3-70 Postmen, Mailsorters, Messengers
3-80 Telephone and Telegraph Operators
8-54 Radio and Television Repairmen
8-56 Telephone and Telegraph Installers/Repairmen
8-57.40 Telephone and Telegraph Linesmen
8-61 Broadcasting Station Operators

Source: OECD (1981, volume 1, pp. 122-124).

Table 33

Comparison of the OECD Occupational Typology
with those of Machlup and Porat

1) Deletions compared to Porat and Machlup		MACHLUP	PORAT
0-14	Physical and clinical scientists	X	X
0-25	Chemical engineers	X	X
0-33	Civil engineers (except construction supervisors and surveyors)	X	X
0-35	Mechanical engineers	X	X
0-36	Chemists	X	X
0-37	Metallurgists	X	X
0-38	Mining engineering	X	X
0-39	Industrial engineers, n.e.c.	X	X
0-41, 0-42, 0-43	Pilots, ships officers (except 0-41.40 flight navigators and 0-42.30 ship navigators)	X	X
0-54	Biologists and agronomists	-	X[1]
0-79	Certain health professions, n.e.c.	-	X[1]
0-84.90	Other statisticians and mathematicians	X	X
1-39	Some educators n.e.c., including education methods advisors and other teaching personnel	X	X
1-40	Members of the clergy	X	-
1-50	Public relations specialists	X	X
1-61	Sculptors and painters	X	-
1-71.3	Arrangers, conductors	X	-
1-71.4	Instrumentalists, singers, band and choral directors	X	-
1-73.20	Actors	X	-
1-73.90	Other actors and stage directors	X	-
1-75	Circus performers	X	-
1-79.30, 1-79.90	Hosts, MCs	X	-
1-80	Athletes, sportsmen, coaches, instructors	X	-
1-91	Librarians, archivists and museum curators	X	X
1-93	Social workers	X	X
1-94	Labour relations specialists, education and vocational counselors	X	X

---

n.e.c.: not elsewhere classified.

1 Calculated at 50 %, based on the inclusive definition.

Table 33

Comparison of the OECD Occupational Typology
with those of Machlup and Porat
(cont.)

		MACHLUP	PORAT
1)	Deletions compared to Porat and Machlup (cont.)		
1-95	Translators and interpreters	X	-
1-99	Other workers in scientific, technical, liberal and related professions: other engineers, home management advisors, astrologists, etc.	X[2]	X[2]
3-31	Bookkeepers, clerks, bank employees, etc.	X	X
3-60	Train conductors and ticket collectors	X	X
3-91.40	Stock clerks	X	-
4-10.30	Owner-managers (retail trade)	-	X[1]
4-32	Travelling salesmen and representatives	Q[3]	X
4-51, 4-52, 4-90	Salesmen (wholesale, retail), demonstrators	Q[3]	X[1]
9-29	Compositors, type-setters and workers n.e.c.	X	X
0-71, 0-72	Nurses	-	X[1]
0-76	Physiotherapists and occupational therapists	-	X
9-39.50	Sign and letter painters	-	X
9-83.50	Train conductors	-	X[1]
2)	Additions compared to Porat and Machlup		
0-69	Dieticians and nutrition specialists	-	X[1]
0-75	Optometrists (excluding opticians)	-	X
1-62	Decorators	X	-
1-71.20	Musical composers	X	X
4-00	Managers (wholesale and retail)	Q[4]	-
5-31.20	Cooks	X	X
5-81.20	Fire prevention specialists	X	X
5-89.20	Private investigators	X	X
8-49.65	Office machine repairmen	X	-
8-54	Radio and television repairmen	X	-
8-56	Telephone and telegraph installers/repairmen	X	-
8-60	Broadcasting station operators, audio-visual operators and projectionists	X[5]	-
6-00.30	Farm managers	X	X*
7-00	Foremen and related	X	X*

---

n.e.c.: not elsewhere classified.

1 Calculated at 50 %, based on the inclusive definition.
2 Several
3 Wholesale trade only
4 Retail trade
5 Except radio operators

Porat listed the first two types under "co-ordination specialists and market analysts", with clerical personnel listed under "information processing specialists". For Porat, this last category also included inspectors, estimators, etc. ("information gatherers"), which the OECD has listed under "information producers", more specifically in the information gatherers category.

When a professional category was included or excluded by the OECD, it was included or excluded entirely. There are no occupations with an ambiguous informational status, or occupations calculated at a rate of 50%. The lack of time/budget studies among member countries partially explains this divergence from Porat's typology. Technical professions were excluded on a grand scale, whereas Porat counted them. In Machlup's study, health technicians were included. Like Porat, the OECD eliminated religious occupations, sculptors, painters, artists, musicians, actors, athletes, hosts and MCs, instructors and translators. They retained repairmen/installers of material and equipment (radio, television, office machines, etc.) and film projectionists, which were not included in Machlup's typology. The OECD typology is close to Machlup's in that it added decorators and optometrists to Porat's typology. Overall, the OECD deleted more occupational categories than Porat, even though its typology was more aggregate. The OECD grouped educators, for example, into 5 categories, compared to Porat's 31, and engineers into 7, compared to Porat's 11.

c) Rubin and Sapp (1981)

Drawing from the work of Porat and Rubin and the OECD, Rubin and Sapp identified and quantified the number of information workers for the period 1870-1970[1]. According to this approach, the proportion of information workers in the U.S. labour force went from 8% to 41% in a century. They then evaluated the level of unemployment from 1962 to 1979. Government statistics were so aggregate that the authors calculated the information phenomenon by following the "white collar" professions. They noted that the average level of unemployment among white collar workers was lower than unemployment in other professional categories over the same period.

Rubin and Sapp used 70 professions in their typology, compared to approximately 190 used by Porat and nearly 120 used by the OECD.

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[1] RUBIN, Michael Rogers and Mary SAPP (1981).

Their occupational typology is presented in Table 34. It is divided into four groups and 11 sub-groups, the same as those used by the OECD[1]:

- Information producers:
  . Scientific and technical
  . Market search and coordination
  . Information gatherers
  . Consultative services

- Information processors:
  . Administrative and managerial
  . Supervisory
  . Clerical

- Information distributors:
  . Educators
  . Communications workers

- Information infrastructure:
  . Machine workers
  . Postal and telecommunications

The similarity to the OECD typology extended to excluding technicians (except draftsmen and surveyors), librarians and archivists, social workers, labour relations specialists and vocational counselors, members of the clergy, public relations specialists, translators and interpreters, nurses and chemical engineers. No attention was paid to ship officers, airline pilots and navigators, cooks, fire prevention specialists or private investigators. As far as wholesale and retail trade was concerned, clerical personnel, as well as sales and advertising personnel, were included. All office employees are considered, from directors to clerks. The same applies to factory workers: production managers, clerks and foremen are included. The information infrastructure was dealt with in the same manner as in the Porat typology. Printing industry occupations and those involved in repairing office machines and radio and television sets were included. All occupations considered by Rubin and Sapp were included in their entirety (not at a rate of 50%, as with Porat). Compared to other typologies, the most significant exclusions were secretaries and receptionists. Stenographers and typists are included. As far as writers and artists were concerned, Rubin and Sapp applied Porat's system almost entirely, including journalists,

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1 RUBIN, M.R. and M. SAPP (1981, p. 205).

Table 34

Rubin and Sapp (1981) : Typology of Information Occupations

	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870
INFORMATION PRODUCERS											
Chemists	108	84	76	57	45	28	16	9	4	2	1
Physicists	22	14	8								
Physical Scientists	30	23	16								
Civil Engineers	174	158	127	97	88	56	40	20		8	5
Electrical Engineers	282	185	107	63	58	27	15	6			
Mechanical Engineers	178	159	115	62	54	38	15	6	43		
Metallurgists	15	19	12								
Mining Engineers	4	12	14	9	12	7	7	3			
Industrial Engineers	185	115	41	9							
Engineers NEC	372	224	119	29							
Biologists, Zoologists	29	14	9								
Bacteriologists & Pharmacy	110	93	89								
Agronomists	13	8	6								
Statisticians	22	30	27								
Math. and Actuaries	13										
Economists	66	19	9								
Sociologists, etc.	33	16	3								
Purchasing Agents	355	105	64								
Technical Salesmen	412	474	310								
Brokers	815	594	468	390	429	220	172	112	6	4	
Advert. Agents & Salesmen	62	35	34	41	40	25	11	12			
Auctioneers	5	4	5	4	4	5	4	3	3	2	2
Surveyors	60	47	27	17	14	8	7	6			
Inspectors	121	101	99	82	78	77	53	22			
Information Gatherers NEC	53	33	24	45	43	31	36				
Architects	57	38	24	22	23	17	16	11	8	3	2
Draftmen	294	219	136	82	80	52	33	16	8	2	1
Medical Practioners	296	247	236	203	189	163	157	131	105	86	62
Dieticians & Nutritionists	41	27	23								
Optometrists	17	16	15	10	8	7	1				
Systems Analysts	158										
Computer Programmers	161										
Accountants & Auditors	712	496	385	238	192	118	39	23	14	5	3
Lawyers & Judges	273	218	182	182	161	123	115	108	90	64	41
Artists & Designers	112	173	110	98	78	51	46	27	24	10	4
Authors	26	29	16	14	12	7	4	3	2	1	1
INFORMATION PROCESSORS											
Government Administrators	248	195	156	122	130	104	77	87	82	64	41
Managers (Wholesale/Retail)	1434	1681	2320	1845	1747	1363	1233	1008	691	479	358
Production Managers	760	801	669	432	447	406	350	174			
Managers NEC	4021	3031	1951	1371	1290	930	812	428			
Foremen	1617	1186	856	585	551	485	318	162			
Stenos & Typists	3914	2316	1629	1223	1097	786	387	134	33		
Bookkeepers	1572	951	739	721	739	616	447	233	143	33	28
Clerks	7607	5794	4286	4701	2361	1902	1108	632	557	432	259
Proofreaders	28										

Table 34

Rubin and Sapp (1981) : Typology of Information Occupations (cont.)

	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870
INFORMATION DISTRIBUTORS											
University Teachers	486	179	125	75	62	33	16	7	5		
Secondary Teachers	1001	521	371								
Primary Teachers	1414	521	678	1020	1044	752	395	440	342	228	127
Pre-Primary Teachers	125	152	89								
Journalists	147	106	73	66	61	39	36	32	22	12	5
Radio & TV Announcers	22	18	17	4	2						
INFORMATION INFRASTRUCTURE											
Photographers	65	53	55	38	33	29	30	25	20	10	6
Cardpunch	273										
Calculating Machine Operators	98										
ADP Operators	117										
Office Machine Operators	45	318	146	60	38						
Office Machine Repairs	40	30	31								
Comp. & Typesetters	159	193	179	181	184	140	128	36	30		
Printing Pressmen	156	85	50	36	31	19	20	104	86	72	40
Stereotypers	8	9	12	8	8	5	4	3	1		
Printing Engravers	8	12	10	9	18	14	13	11	8	5	4
Photoengravers	33	28	29	23	13	10	10				
Bookbinders	34	30	32	19	19	19	17	26	29	14	9
Photoprocessors	63	47	30	15	8	3	2	2			
Postmen & Messengers	734	265	217	211	245	235	216	100	51	14	9
Telephone Operators	407	372	367	239	315	272	166	75	52		
Radio & TV Repairmen	137	105	79								
Telephone/Telegraph Inst.	238	N/A	N/A								
Telephone/Telegraph Linesmen	52	33	26	104	72	38	28	15	11		
Broadcast Operators	28	18	17	7	5	5	4				
Information Workers	32777	23569	18175	14863	12128	9265	6594	4254	2469	1550	1009
Total Workers	79802	67990	59230	51742	48686	42206	37291	29287	22736	17392	12505
% of Information Workers	41,0	34,7	30,7	28,7	24,9	22,0	17,7	14,5	10,9	8,9	8,0

Source: RUBIN et SAPP (1981, p. 208).

photographers, publishers, authors, and radio and television announcers. Whereas designers were only considered at a rate of 50% in the inclusive definition, with Rubin and Sapp they were considered in full.

d) Canada Consulting Group (1984)

In 1984, the Canada Consulting Group produced an analysis of the information economy[1]. The secondary information sector was quantified based on the following list of occupations:

11	Managerial
21	Natural Sciences, Engineering, Mathematics
23	Social Sciences
27	Teaching
3111	Physicians and Surgeons*
313	Nursing, Therapy and Related Assisting Occupations*
3156	Medical Lab Technologists*
331	Fine and Commercial Art
333	Performing and Audio Visual Arts
335	Writing
336/7	Coaches*
41	Clerical
513/4	Sales, Commodities*
517	Sales, Services
519	Sales, Other*
951	Printing
959	Equipment Operating, not elsewhere classified

* These activities are considered at a rate of 50%.

The authors endeavoured to follow Porat's occupational typology in so far as possible, given the high aggregation of the professions included. As a result, several occupational groups were considered at 50%, as in Porat's inclusive definition. The codes used are SIC codes (1971).

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[1] CANADA CONSULTING GROUP (1981).

e) Raul Katz (1986)

In 1986, Raul Katz presented his doctoral thesis on international measurements of the information labour force[1]. He employed the OECD occupational typology for a number of countries: Argentina, Bahrain, Brazil, Chile, Egypt, Ghana, Hong Kong, India, Iran, Korea, Kuwait, Mexico, Pakistan, Panama, the Philippines, Singapore, Sri Lanka, Syria, Tunisia and Venezuela. The extent of information occupations in these various economies fluctuated substantially from one country to another: from 6.4% in Pakistan to 30% in Singapore (1980).

Katz evaluated professional occupations for 1960, 1970 and 1980. In his analysis of developing countries, he worked on a more aggregate basis in using the OECD typology. Groups 1, 2 and 3 of the International Standard Occupational Classification (International Labour Office - 1980) were considered in full, i.e. scientists, technicians, administrators and clerical employees. This implies then that a certain number of OECD information occupations were ignored. These are listed in Table 35. Nonetheless, Katz viewed the methodology employed as a quick evaluation method. He estimated the margin of discrepancy with full application of the OECD typology at roughly 4%.

2.1.4 Research carried out by Information Professionals

a) Gupta and associates (1974)

In 1969, the University of Pittsburgh created an interdisciplinary doctoral program in information science. In 1972, the university's School of Library and Information Science conducted a study on demand for information professionals. Gupta, Shirey and Debons (1974) attempted to make up for the lack of data on the matter existing at the time. They concentrated on evaluating demand for Bachelor's, Master's and Ph.d graduates in information science from industry, government and the academic sector. The survey of these labour markets was of major interest, but it proved to be difficult to identify information professionals on the basis of their academic qualifications.

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[1] KATZ, Raul (1986).

Table 35

Occupation Codes used by the OECD
and excluded by Katz*

I. Information Producers

- Market search and coordination specialists:

4-10.20	Commodity brokers
4-22	Purchasing agents and buyers
4-31	Technical salesmen and advisers
4-41	Insurance and stock agents, brokers and jobbers
4-42	Business services/advertising salesmen
4-43.20	Auctioneers

II. Information gatherers

4-43.30	Valuation surveryors
7-54.70	Fabrics examiners
8-59.20	Inspectors, viewers, and testers
9-49.80	Quality inspectors
5-89.20	Private inquiry agents

III. Information processors

- Administration and managerial:

4-00	Managers (wholesale/retail trade) Process control and supervisory
4-21	Sales supervisors
5-20	Housekeeper
5-31.20	Head cook
6-00.30	Supervisors: clerical, sales, and other
6-32.20	Forest supervisors
7-0	Supervisors and general foremen (production)

IV. Information infrastructure occupations

- Information machine workers:

8-49.65	Office machine repairmen
8-62	Sound and vision equipment operators
9-21	Compositors and typesetters
9-22	Printing pressmen (except 9-22.70)
9-23	Stereotypers and electrotypers
9-24	Printing engravers (except 9-24.15 and 9-24.30)
9-25	Photoengravers
9-26	Bookbinders and related
9-27	Photographie processors

- Postal and telecommunications:

8-54	Radio and television repairmen
8-56	Telephone and telegraph installers/repaimen
8-57.40	Telephone and telegraph linesmen
8-61	Broadcasting station operators

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* The codes preceding the occupation are International Standard Industry Classification codes from the International Labour Office.

Source: KATZ, R. (1986, p. 268).

b) Debons et associates (1981)

In April 1976, the University of Pittsburgh held a symposium entitled "Manpower Requirements for the Information Professional". Discussion was extended by establishing a group of researchers charged with identifying and quantifying information professionals. To this end, an extensive survey was undertaken: "The Occupational Survey of Information Professionals (1980)". Unlike Gupta et al. (1974), Debons, King, Mansfield and Shirey (1981) focused on the tasks carried out, rather than on academic qualifications or traditional job classifications.

They defined information professionals on the basis of three criteria:

- they carried out at least one information task that constituted the major activity of their work;
- did so they devoted 50% or more of their time to this task, or at least in their employer's opinion;
- the information tasks were professional level tasks, in that a university degree or equivalent experience was required to carry out the work.

In sum, information professionals differ from others who work with data in that they are interested in content and meaning, and use the data in a cognitive and intellectual manner[1].

This approach distinguished them from earlier researchers. Emphasis was placed exclusively on "scholars" (as with Plato), but within professions carrying out information tasks (as with Porat and the OECD). Table 36 presents the various tasks included as information tasks, as well as certain titles of corresponding occupations.

In this manner, several professionals working in positions involving extensive information were excluded, notably managers of departments or programs other than information programs, journalists, publishers, educators, lawyers, and many professionals often viewed as creators and/or primary users of information. Table 37 elaborates further on these exceptions. In addition, the use of information tasks as a system of reference meant including occupations that appear to have little to do with information occupations. Engineers, meteorologists, hydrologists, biologists

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[1] DEBONS et al. (1981, pp. 29-31).

Table 36

The Approach of Debons et al. (1981)

INFORMATION DUTIES	CORRESPONDING JOB TITLE
1. **Managing Information Operations, Programs, Services, or Database.** Includes planning, directing, or administering information operations, programs, services, or databases; establishing budgets, funding, and financial control; planning and controlling resource-sharing or networking activities; establishing and implementing security standards for information systems; forming and implementing corporate information policies; integrating information operations, programs, services or databases with mission of parent organization; surveying users to establish information needs; promoting information products and services.	Audiovisual Administrator, Chief Programmer, Comptroller, Database Manager, Director of Information Center, Library Administrator, Library Director, Manager of Publishing Unit, Management Analyst, Media Manager, Science Editor, Vice-President for Information, etc.
2. **Preparing Data and Information for Use by Others.** Includes technical writing (but not public relations promotions), editing, or other scientific publishing activities involving journals, technical reports, manuals, instructions, etc.; translating business, scientific, or technical works from one language to another; preparing abstracts, indexes, or catalogs; compiling bilbiographies, reference materials, or referral materials; preparing lists or directories of people, buildings, events, etc.; establishing a computer numeric or textual data input requirement; transforming data into form required by a computer (or other automated system), operational system, or library; preparing other information materials, such as audiovisual or cartographic materials.	Abstractor, Archivist, Bibliographer, Cataloger, Classifier, Librarian (Research), Librarian (Special Collections), Medical Records Specialist, Science Editor, Survey Data Editor, Technical Editor, Technical Writer, and Translator.
3. **Analyzing Data and Information on Behalf of Others.** Includes researching and analysis (but not final use) of data and information from a library, computer file, or other database; analysis of data and information that goes beyond (but which may include) such activities as abstracting, or simple summarization of previously-written materials, computer system output, or library materials.	Analysis Specialist, Information Counselor, Operations Analyst, Research Assistant, and subject specialists (e.g., Economic Analyst, Financial Analyst, Management Analyst, User Consultant, etc.)

Table 36

The Approach of Debons et al. (1981)
(cont.)

INFORMATION DUTIES	CORRESPONDING JOB TITLE
4. **Searching for Data and Information on Behalf of Others.** Includes diagnosing user needs for information; identifying data sources, and developing search strategies; accessing databases either manually (library shelves) or Electronically (automated system); evaluating yield of data searches (but not performing analysis of data); referring users to other sources of data and information.	Information, Counselor, Reference Librarian, Reference Specialist, Referral Specialist, Searcher, Technical Information Specialist, etc.
5. **Remaining Operational Information Functions.** Includes supervising the running of a library of automated information system; controlling and facilitating access procedures; developing and implementing procedures for data input to systems (including library acquisitions); developing and implementing software packages for computer systems; designing applications programs to fit user needs.	Applications Programmer, Archivist, Audiovisual Specialist, Librarian (Acquisitions), Librarian (Medical Records), Librarian (Special Collections, etc.
6. **Information Systems Analysis.** Includes analyzing existing work processes; determining the feasibility of system automation; determining output product and form; selecting data or information for inclusion in the system; recommending design alternatives; evaluating information systems, products or services.	Computer Systems Analyst, Chief Programmer, Data Processing Systems Analyst, Operations Researcher, Senior Programmer, Software Specialist, Systems Analyst, Word Processing Systems Analyst, etc.
7. **Information Systems Design.** Includes disigning new systems or modifying existing systems; establishing procedures for carrying out work processes; implementing system design; evaluating system output to insure that it meets user requirements; documenting the procedures for use of the system, both for system personnel and for users.	Computer Systems Planner, Database Designer, Methods Analyst, Operations Designer, Senior Programmer, Systems Designer, Systems Project Planner, Word Processing Systems Planner, etc.

Table 36

The Approach of Debons et al. (1981)
(cont.)

INFORMATION DUTIES	CORRESPONDING JOB TITLE
8. **Information Research and Development.** Includes studying the foundations, laws, theories, and postulates related to information and information systems, operations, programs, services, or databases; performing research on new forms of information systems, operations, products, processes, and services; developing models of information systems or operations; designing, collecting, and analyzing secondary and primary data in information research; research on the use of information systems, products, or services; research on information user behavior and characteristics.	Communications Researcher, Computer Scientist, Information Scientist, Library Scientist, persons with methods expertise (e.g., in Operations Research, Psychology, Statistics, Systems Analysis, etc.) and persons with subject expertise (e.g., in Behavioral Science, Engineering, Mathematics, Philosophy, etc.).
9. **Educating and Training Information Workers.** Includes teaching courses on information subjects to undergraduate or graduate students; training information professionals or other workers on the job, or in workshops or seminars; planning information education programs; developing information curricula; research on information education.	Faculty Member (College or University), Instructor, Lecturer, Training Officer, etc.

Source: DEBONS et al. (1981, p. 36, 38).

Table 37

Debons et al. (1981): List of Exceptions

Managers and administrators other than managers and administrators of information programs and resources; because their purpose in using data and information is to manage and control, not to assist a third party to become informed.

Salespersons other than those selling information products or services; because their dissemination of information is aimed at selling a product or service, not just at helping the client to reach an informed state ("detail men" being a possible exception).

Workers in the information field who operate below the professional level; simply because this project was limited to identify information "professionals" as distinct from information workers in general.

Professionals in the information field who work only with hardware design and development; because they are not usually concerned with the cognitive operations of the primary user of system output, their main concern being machine performance.

Professionals in information fields such as education, law, journalism, etc., other than those in these fields whose primary activity is aimed at assisting a third party to reach an informed state; because their professional activity usually involves a level of synthesis much deeper than that required of an information professional, and as such makes them creators of information.

Researchers other than those who research with information (i.e., solve research problems by gathering, analyzing, and interrelating data from a combination of sources); because they are primary users of data and information.

Advertising professionals other than those involved in the promotion of information products and services; because the level of persuasion in their communication with clients goes beyond merely helping them to reach an informed state.

Source: Debons et al. (1981, pp. 32-33)

and geologists were considered, even though they work outside spheres in which most information processing professionals are found: departments of information, management support, information and documentation, finance and statistics, training and teaching, research and technical publications.

In 1980, 1.6 million information professionals were identified in the U.S., with a margin of error estimated at approximately 0.2 million.

2.2 Professions Involved in the Computerization Process

2.2.1 Agence de l'Informatique (1986): Professions in Computer Science

The Agency made a study of occupations in Computer Science: computer specialists and input staff[1]. These professions represented 1.21% of the active French labour force in 1985. Based on the 1982 census, persons claiming a profession in the computer field were categorized according to their qualifications on either the supply or demand side (Table 38).

Table 38

Agence de l'Informatique (1986): The Professions in Computer Science

	Manufacture of Computer Equipment	Information and Computer Service Firms	User Firms	Total
Senior Management	45 %	38 %	17 %	27 %
Technical-Commercial	29 %	4 %	1 %	4 %
System Operator/Manager	3 %	7 %	10 %	8 %
Programmers	16 %	21 %	19 %	19 %
Operating Staff	4 %	7 %	21 %	19 %
Input Staff	3 %	24 %	34 %	27 %
	100 %	100 %	100 %	100 %

Source: AGENCE DE L'INFORMATIQUE (1986, p. 96)

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[1] AGENCE DE L'INFORMATIQUE (1986).

2.2.2 Roland Jouandet-Bernadat (1979): Telematics Professions

Roland Jouandet-Bernadat considered certain occupational categories as indicators of the computerization of the economy[1]. He employed a telematics definition of the phenomenon:

2183 Systems Analysts, Computer Programmers and Related Occupations

414 Office Machine and Electronic Data-processing Equipment Operators

4140 Supervisors: Office Machine and Electronic Data-processing Equipment Operators

4141 Office Machine Operators

4143 Electronic Data-processing Equipment Operators

955 Electronic and Related Communications Equipment Operating Occupations, n.e.c.

9550 Foremen: Electronic and Related Communications Equipment Operating Occupations, not elsewhere classified

9551 Radio and Television Broadcasting Equipment Operators

9553 Telegraph Operators

9555 Sound Recording and Reproduction Equipment Operators

9557 Motion Picture Projectionists

9559 Electronic and Related Communications Equipment Operating Occupations, n.e.c.[2]

Jouandet-Bernadat assessed the breakdown of these professions within each industry in the Canadian economy. An indication of the level of industry computerization was obtained by comparing the share of these professions with the total number of occupations in the various sectors. Data from the 1971 census were used as input, particularly the occupational breakdown per industry.

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1 JOUANDET-BERNADAT, Roland (1979).

2 The codes used are SOC codes (1971).

Table 39 presents the most important results. Note that the insurance sector appears to be the most computerized (5.4%) compared to the agricultural sector, which is the least affected at 0,0007%.

The author was conscious of the limits of an indicator that does not focus strictly on the extent of the computerized labour force. Certain occupations involved in operating office machines were not included. In addition, a portion of this labour force works outside the three occupational categories. There is a lack of information regarding the number of personnel employed in telecommunications within each industry. He viewed these occupational codes as a basis for further study.

Table 39

Jouandet-Bernadat (1979): Industrial Breakdown of Computerization Occupations in Canada - 1971

	Level of Computerization
1. Insurance	5,47 %
2. Manufacture of Non-Electrical Machinery	3,89 %
3. Financial Institutions	3,81 %
4. Communication	3,39 %
5. Mineral Fuels Extraction	3,37 %
6. Manufacture of Petroleum Products	3,22 %
7. Services to Business Management	2,79 %
8. Provincial Government	2,69 %
9. Electric Power, Gas and Water Utilities	2,24 %
10. Federal Government	2,10 %

Ratio: $\frac{\text{Industry computerization occupations}}{\text{Total industry occupations}} \times 100$

Source: JOUANDET-BERNADAT, R. (1979, pp. 12-17).

2.2.3 Raymond Panko (1984): Office Occupations

Panko felt that it was essential that specific office occupations be isolated, and carried out a study of office automation[1]. He began by using the U.S. Bureau of Labor Statistics (B.L.S.) definition of "white collar" workers. Table 40 lists the occupations in question. His deletions, compared to the B.L.S. typology, are listed in Table 41.

In 1983, the B.L.S. applied a new occupational classification. "white collar" and "blue collar" categories disappeared and were replaced by a broader definition. Panko readapted his typology, taking these changes into account. The asterisks in Table 42 indicate his deletions, compared to the Bureau of Labor Statistics categories (1983).

Notwithstanding the changes made to occupational classifications in 1983, office occupations accounted for approximately 39% of employment in the U.S. (38.5% before, 39.8% after), compared to 54% for the B.L.S. "white collar" category (53.7% before, 54.2% after). He also noted that industries with a high proportion of office occupations tend towards greater computerization. However, the co-relation between the number of these workers and the use of technology is still far from a 1/1 ratio.

Table 43 presents a comparison of some occupational typologies described in this chapter for a clearer picture of the differences in approach.

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[1] PANKO, R. (1984).

Table 40

Panko (1984): Office Occupations (before 1983)

PROFESSIONAL AND TECHNICAL

- Accountants
- Architects
- Computer specialists
- Engineers
- Lawyers and judges
- Librarians, archivists, and curators
- Life and physical scientists
- Operations and systems researchers & analysts
- Personnel & labor relations workers
- Physicians, dentists and related
- Religious workers
- Social scientists
- Teachers, college and university
- Vocational & educational counselors
- Writers, athletes, and entertainers[1]
- Research workers, not specified
- All other

MANAGERS AND ADMINISTRATORS, EXCEPT FARM

- Bank officials and financial managers
- Buyers and purchasing agents
- Credit and collection managers
- Health administrators
- Inspectors, exc. construction, public admin.
- Managers and superintendents, building
- Office managers, n.e.c.
- Officials; public administration, n.e.c.
- Officials of lodges, societies, unions
- Restaurant, cafeteria, bar managers
- Sales managers and dept. heads, retail
- Sales managers, except retail
- School administrators, college
- School administrators, elementary & secondary
- All other managers and administration

SALES WORKERS

- Advertising agents and sales workers
- Insurance
- Real estate agents and brokers
- Stock and bond sales agents
- Sales workers and sales clerks, n.e.c.[2]

CLERICAL WORKERS

- Billing clerks
- Bookkeepers
- Clerical supervisors, n.e.c.
- Collectors, bill and account
- Dispatchers and starters, vehicle
- Enumerators and interviewers
- Estimators and investigators, n.e.c.
- Expediters and production controllers
- File clerks
- Insurance adjusters, etc.
- Library attendants and assistants
- Messengers and office helpers
- Office machine operators
- Payroll and timekeeping clerks
- Receptionists
- Secretaries
- Shipping and receiving clerks
- Statistical clerks
- Stenographers
- Stock clerks and storekeepers
- Typists
- All other clerical

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1 Excludes entertainers, musicians, painters, and photographers.
2 Excludes retail sales clerks.

Source: PANKO, R. (1984, pp. 208-209).

Table 41

Panko (1984): Deletions made to the BLS List of White Collar Workers

1. Professional and technical

- Foresters and conservationists
- Nurses, dieticians, and therapists
- Health technologists and technicians
- Social and recreation workers
- Teachers, except college and university
- Engineering and science technicians
- Technicians, other
- Entertainers, musicians, painters and photographers

2. Managers and administrators, except farm

None

3. Sales workers

- Demonstrators
- Hucksters and peddlers
- Newspaper carriers and vendors
- Retail sales clerks

4. Clerical workers

- Bank tellers
- Cashiers
- Counter clerks, except food
- Mail carriers, post office
- Mail handlers, except post office
- Postal clerks
- Teachers'aides
- Telephone operators
- Ticket, station and express agents

Source: PANKO, R. (1984, pp. 208-209).

Table 42

Panko (1984): Office Occupations (after 1983)

MANAGERIAL AND PROFESSIONAL SPECIALTY

Executive, administrative, and managerial
- Officials and administrators, public admin.
- Other except, admin., managerial
- Management-related occupations

Professional specialty
- Engineers
- Mathematical and computer scientists
- Natural scientists
- Health diagnosing occupations
- *Health assessment and treatment
- Teachers, college and university
- *Teachers, except college and university
- Lawyers and judges
- Other professional specialty

TECHNICAL, SALES AND ADMINISTRATIVE SUPPORT

*Technicians and related support

Sales occupations
- Supervisors and proprietors
- Sales representatives, fin. & bus. services
- Sales reps., commodities, except retail
- *Sales workers, retail and personal services
- Sales-related occupations

Administrative support, including clerical
- Supervisors
- Computer equipment operators
- Secretaries, stenographers, and typists
- Financial records processing
- *Mail and message distribution
- Other administrative support

* Deletions made by Panko compared to the B.L.S. occupational classification.

Source: PANKO, R. (1984).

Table 43

Comparison of Various Occupational Typologies

OCCUPATIONS	APPROACHES				
	MACHLUP (1962)	PORAT (1977)	OCDE (1981)	RUBIN, SAPP (1981)	PANKO (1985)
I -"PROFESSIONAL AND TECHNICAL"					
Accountants	X	X	X	X	X
Architects	X	X	X	X	X
Computer operators and programmers	X	X	X	X	X
Engineers	X	X	Q[1]	X	X
Foresters and consultants	X	X	X	-	-
Lawyers and judges	X	X	X	X	X
Librarians, archivists and curators	X	X	-	-	X
Scientists (physical and health sciences)	X	X	X	X	X
Researchers and systems analysts	-	X	X	X	X
Labour relations professionals	X	X	-	-	X
Doctors, dentists and staff (exc. optometrists)	Q[2]	Q[3]	X	Q[4]	X
Optometrists	X	-	X	X	X
Nurses and nutritionists	Q[5]	Q[6]	Q[5]	Q[7]	-
Health technologists and technicians	-	Q*	-	-	-
Members of the clergy	X	-	-	-	X
Scientists (social and human sciences)	X	X	X	X	X
Social workers	X	-	-	-	-
Professors, colleges and universities	X	Q[8]	Q[8]	X	X
Engineers and technicians in applied sciences	X	X	Q[9]	Q[9]	-
Technicians, others	Q[10]	Q[11]	Q[12]	-	-
Educational and vocational counselors	X	X	-	-	X
Writers, atheletes and entertainers	X	Q[13]	Q[14]	Q[15]	Q[16]
Researchers n.e.c.	X	X	-	-	X
Professors, other than in colleges and universities	X	X	X	Q[17]	X
Other professionals and technicians	X	Q[18]	Q[18]	Q[19]	X

- : Excluded Q : Some restrictions X : All items are considered * : Included only in inclusive definition (at 50%) [1] Except chemical engineers; [2] Surgeons* and physicians*, exc. veterinarians, dentists & chiropractors; [3] Inc. doctors*, exc. dentists, veterinarians and pharmacists; [4] Exc. dentists, veterinarians et pharmacists; [5] Exc. nurses and therapists; [6] Nurses and dieticians*: Inc. therapists; [7] Only dieticians; [8] Exc. phys.ed. profs and coaches; [9] Exc. surveyors and designers; [10] Exc. morticians; [11] Exc. interpreters, translators, morticians and airlines pilots; [12] Exc. morticians, translators, interpreters & airlines pilots, but inc. navigators; [13] Exc. actors, athletes, dancers, musicians and other artists. Designers*; [14] Exc. actors, designers, athletes, other artists and musicians. Inc. only composers, stage directors, TV and radio producers; [15] Inc. designers, journalists; radio/TV announcers and photographers; [16] Exc. entertainers, painters, musicians and photographers; [19] Match specialists n.e.c. only.

Table 43 (cont.)

Comparison of Various Occupational Typologies

OCCUPATIONS	APPROACHES				
	MACHLUP (1962)	PORAT (1977)	OCDE (1981)	RUBIN, SAPP (1981)	PANKO (1985)
II - MANAGERS AND ADMINISTRATORS, EXCEPT FARM				(Rubin and Sapp	
Bank officials and financial managers	X	X	X	listed 4 groups	X
Buyers and purchasing agents	Q[20]	X	X	in this category:	X
Credit and collection managers	X	X	X		X
Health administrators	X	X	X		X
Inspectors, exc. construction, public administration	X	X	X	-"public	X
Managers and superintendents, building	X	X	X	administration"	X
Office managers, n.e.c.	Q[21]	Q[22]	X	-"managers	X
Official of lodges, societies, unions	X	*	X	(retail)"	X
Officials, public administration, n.e.c.	X	X	X	-"production	X
Restaurant, cafeteria, bar managers	-	-	-	managers"	X
Sales managers and dept. heads, retail	-	*	X	-"mgt. n.e.c."	X
Sales managers, except retail	X	*	X		X
School administrators, college	X	X	X	the number of	X
School administrators, elementary and secondary	X	X	X	professions	X
Funeral directors	-	-	-	approximately	X
Train conductors	-	*	-	corresponds to the	-
Officers, pilots, ships officers	-	*	Q[26]	number obtained	-
Comptrollers, treasurers, public administration	X	X	X	by including all	X
Superintendents and postmasters	X	X	X	these various	X
Inspectors, public administration (construction)	X	X	X	professions)	X
Other managers and administrators n.e.c.	Q[23]	Q[24]	Q[25]		Q
III - SALES WORKERS					
Advertising agents and sales workers	Q (Retail trade	X	X	X	X
Demonstrators	occupations	*	-	-	-
Peddlers and travelling salesmen	excluded)	*	-	-	-
Insurance agents and brokers		X	X	X	X
Occupations related to newspaper sales		*	-	-	-
Real estate agents and brokers		X	X	X	X
Stock and bond sales agents		X	X	X	X
Sales workers and clerks, n.e.c.		Q[27]	Q[28]	Q[29]	Q[27]

- : Excluded Q : Some restrictions X : All items are considered * : Included only in inclusive definition (at 50%) [20] Exc. retail trade personnel; [21] Exc. funeral directors and repair services trades; [22] Exc. funeral directors, and inc. managers (retail trade, personnel and business services)*; [23] Exc. repair services and retail trade occupation; [24] All but retail, personnel and business service managers*; [25] Exc. owner-operators (retail trade); [26] Navigation officers only; [27] All but retail trade staff*; [28] Exc. non-technical sales agents and clerks; [29] Only technical sales agents;

Table 43 (cont.)

Comparison of Various Occupational Typologies

OCCUPATIONS	APPROACHES				
	MACHLUP (1962)	PORAT (1977)	OCDE (1981)	RUBIN, SAPP (1981)	PANKO (1985)
IV - OFFICE WORKERS					
Bank tellers and clerks	X	X	-	X	-
Billing clerks	X	X	X	X	X
Bookkeepers	X	X	X	X	X
Tellers and clerks, except bank	X	X	-	X	X
Office supervisors, n.e.c.	X	X	X	X	X
Collectors, bill and account	X	X	Q[30]	X	X
Counter clerks (except food)	X	*	Q[30]	X	-
Dispatchers	X	X	X	X	X
Enumerators and interviewers, n.e.c.	X	X	X	X	X
Expediters and production controllers	X	X	X	X	X
File clerks	X	X	X	X	X
Insurance adjusters	X	X	X	X	X
Library attendants and assistants	X	X	X	X	X
Postmen	X	X	X	X	-
Distributors and delivery personnel (except postal)	X	X	X	X	-
Messengers	X	X	X	X	X
Office machine operators	X	X	X	X	X
Payroll clerks	X	X	X	X	X
Postal clerks	X	X	X	X	-
Receptionists	X	*	X	X	X
Secretaries	X	X	X	X	X
Shipping and receiving clerks	X	X	X	X	X
Statistical clerks	X	X	X	X	X
Stenographers	X	X	X	X	X
Stock clerks and storekeepers	X	-	X	X	X
Teaching assistants	X	X	X	X	-
Telephone operators	X	X	X	X	-
Train ticket agents	X	X	X	X	-
Typists	X	X	X	X	X
Revisers	X	X	X	X	X
Meter readers (public utilities)	X	X	-	X	X

- : Excluded Q : Some restrictions X : All items are considered * : Included only in inclusive definition (at 50%) [30] Only employees who do not collect, receive or make payments;

Table 43 (cont.)

Comparison of Various Occupational Typologies

OCCUPATIONS	APPROACHES				
	MACHLUP (1962)	PORAT (1977)	OCDE (1981)	RUBIN, SAPP (1981)	PANKO (1985)
IV - OFFICE WORKERS (cont.)					
Proof readers	X	X	X	X	X
Real estate appraisers	X	X	X	X	X
Telegraph operators and messengers	X	X	X	X	X
Other office workers	X	Q	Q	X	X
V - RELATED WORKERS					
Bookbinders	X	X	X	X	-
Compositors and typesetters	X	X	X	X	-
Stereotypers and electrotypers	X	X	X	X	-
Engravers (except photoengravers)	X	X	X	X	-
Inspectors, scalers and graders (forestry)	-	*	-	X	-
Inspectors, n.e.c.	-	*	-	X	-
Mechanics and repairmen					
. Data processing machines	-	X	X	X	-
. Office machines	-	X	X	X	-
. Radio and television sets	-	X	X	X	-
Photogravers and lithographers	X	X	X	X	-
Printing press operators	X	X	Q[31]	X	-
Telephone installers/repairmen	-	X	X	X	-
Telephone linemen	-	X	X	X	-
Film projectionists	-	X	X	X	-
Printing apprentices (except press operators)	-	X	X	?[32]	-
Sign painters	-	X	-	-	-
Foremen, n.e.c.	-	*	X	X	-
Apprentice printing press operators	-	X	X	?[32]	-
VI - OPERATIONS, EXCEPT TRANSPORT					
Production line supervisors and section heads	-	*	X	-	-
Inspectors, testers, controllers (manufacturing)	-	*	Q[33]	-	-
Samplers and graders (manufacturing)	-	*	Q[34]	-	-
Photo development workers	-	X	X	-	-
Firemen (fire prevention only)	-	-	X	-	-
Private detectives	-	-	X	-	-

- : Excluded Q : Some restrictions X : All items are considered * : Included only in the inclusive definition (at 50%)
31 Except wallpaper printers; 32 Treatment of apprentices is imprecise; 33 Only fabric controllers, manufacturing controllers (electric and electronic appliances) and quality controllers. Exc. mechanical construction controllers/checkers; 34 Exc. fiber sorters and graders.

3. BASIS AND LIMITATIONS OF SELECTED APPROACHES

In the preceding sections, we presented various industrial and occupational typologies, grouping them according to their similarities. This chapter will focus on the basis and limitations of the two major approaches: the knowledge/information economy, and the computerized economy. We shall review the major concepts employed in each approach, their definitions of the phenomenon, causes and factors in development, and the relevance of each approach for future analytical purposes. Table 44 compares both approaches according to the major elements to be reviewed.

3.1 The Knowledge/Information Economy

The first approach includes the efforts of Machlup, Porat, Rubin, the OECD, Daniel Bell and others who base their analysis on knowledge or information. They studied the significant growth of activities related to the production, processing and distribution of knowledge or information (see Table 45). The phenomenon studied is the informationalization[1] of the economy throughout the 20th century. It is seen as resulting from the historical transformation of our society from an agrarian economy to an industrial economy, and then to a service economy and an information economy.

These analyses gave rise to specific groupings of occupations, industries or sectors and provided estimates on the growth of information activities, "realities" that had previously been hidden under traditional classifications.

Generally speaking, these industrial groupings cover knowledge creation and production activities, the communication and distribution of information, risk management activities, co-ordination, research and the processing and dissemination of information. They also often include industries that produce information goods and support industries (e.g. office buildings and schools). Industries producing information goods and services were counted, as were industries whose output, while not directly informational, was necessary to information activities.

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[1] This term was mainly popularized by Japanese researchers at Densoken (Research Institute of Telecommunications and Economics - RITE), including Okada (1978), Komatsuzaki (1985) and Ohira (1987).

Table 44

Comparaison of the Two Major Research Trends

FEATURES	INFORMATION ECONOMY	COMPUTERIZED ECONOMY
1. Driving force	Information	Technology
2. Phenomenon	Informationalization	Computerization
3. Historical process	Transformation of the economy: a) from an agrarian economy b) to an industrial economy c) to a service economy d) to an information economy	Industrial revolutions based on: a) the steam engine b) the internal combustion engine and electricity c) informatics, telematics, microelectronics, etc.
4. Researchers who brought it to public attention	Machlup, Bell, Porat, Lamberton, OECD, Rubin, Serafini and Andrieu	Nora and Minc, Jouandet-Bernadat, Valaskakis, GAMMA Institute, Agence de l'Informatique

Table 44 (cont.)

Comparaison of the Two Major Research Trends

FEATURES	INFORMATION ECONOMY	COMPUTERIZED ECONOMY
5. Major concepts	- Information activity - Information, a market product - Primary and secondary information sectors	- Informatics, telematics, microelectronics, information technologies - Driving activities and user activities - Typologies of activities and workplaces: office and factory occupations, etc.
6. Criticisms	- Imprecise definition of concepts of "information" and "information activity" - Confusing use of the terms "primary", "secondary", "sector" and "activity" - Different activities labelled informational - Primary and secondary sectors can't be compared, as estimates are based on different techniques - Is informationalization a major trend?	- Restrictive definition of technology - Fluctuation in the technologies considered - Demand for "informatics" towards offer of "informatics" services - Technological change increasingly renders obsolete occupational typologies based on the workplace - Is computerization an industrial revolution? - Computerization of electronification?

Table 45

The Knowledge and Information Economy: Major Studies

RESEARCHERS	COUNTRIES STUDIED	CONCEPTS EMPLOYED
. Fritz Machlup (1962, 1975, 1978)	United States	Knowledge industries, knowledge-producing occupations
. George Burck (1964)	United States	Knowledge industries
. Jacob Marschak (1968)	United States	Knowledge industries
. Daniel Bell (1973, 1979)	United States	Knowledge industries, knowledge occupations, secteur quinaire "Société post-industrielle"
. A. Gupta et al. (1974)	United States	Information professionnals
. Anthony Oettinger and P. Shapiro (1975)	United States	Information industries
. Edwin Parker and M.U. Porat (1975)	United States	Information sectors (information occupations and industries)
. Marc Uri Porat (1976)	United States	Information sectors (information occupations and industries)
. D. Lamberton and J. Barnes (1976)	Australia	Information occupations
. L. Ferradon and J.G. de Chalvron (1976)	France	"Activités informationnelles, salariés informationnels"
. Marc Uri Porat and Michaël Rubin (1977)	United States	Information sectors (information occupations and industries)
. Stuart Wall (1977)	United Kingdom	Information occupations
. S. Lange and H. Rempp (1977)	West Germany	Information occupations
. OCDE (1980-1) [inc. S. Serafini and M. Andrieu (1980-1)*]	Canada, Finland, France, Sweden, Austria, Japan, United States West Germany, United Kingdom	Information sectors (information occupations and industries)
. Anthony Oettinger (1980)	United States	Information industries
. Debons et al. (1980-1)	United States	Information professionnals
. N.D. Karunaratne and Alan D. Cameron (1980-1)	Australia, N.Guinea, Papua N.Guinea	Information sectors (information industries and occupations)
. Fritz Machlup (1980, 1982-4)	United States	Knowledge industry, knowledge-producing occupations
. M. Rubin and Elizabeth Sapp (1981)	United States	Information occupations
. Michaël Rubin and E. Taylor (1981)	United States	Primary information sector (information industries)
. K. Uno (1982)	Japan	Knowledge workers
. Charles Jonscher (1982-3)	United States	Information occupations
. Meheroo Jussawalla and Chee-Wah Cheah (1983)	Singapore	Primary information sector (information industries)
. Canada Consulting Group (1984)	Canada	Information sectors (information industries and occupations)
. Patricia Arriaga (1984)	Mexico	Information labor
. R. Vitro (1984)	Venezuela	Information sector
. Hans Jürgen Engelbrecht (1984)	Republic of China, Taïwan	Primary information sector (information industries)

* Serafini and Andrieu focused exclusively on information occupations, not on information industries.

Table 45

The Knowledge and Information Economy: Major Studies
(cont.)

RESEARCHERS	COUNTRIES STUDIED	CONCEPTS EMPLOYED
. Information Economy Company (1984)	Canada, U.K., Germany, Japan, France Mexico, Italy, Brazil, Venezuela, Sweden, Spain, Argentina, Columbia,	Information products
. N.D. Karunaratne (1984-5)	Thailand, Malaysia, Figi Islands, Papua New Guinea, Indonesia Philippines	Primary information sector (information industries)
. D. Gleave, C. Angell, K. Wodley (1985)	England	Information industries and professions
. Sherman Robinson (1986)	United States	Primary information sector (information industries)
. OCDE (1986)	Australia, Denmark, Finland New Zeland, U. S., West Germany Sweden, Norway, United Kingdom	Primary information sector (information industries)
. M. Rubin, W. Huber and E. Taylor (1986)	United States	Knowledge industries, knowledge-producing occupations
. Hans-Jürgen Engelbrecht (1986)	Republic of Korea, Japan	Primary information sector (information industries)
. Komatsuki, Tanimutsu, Ohira & Yamamoto (1985-6?)	Japan	Information economy
. Raul Katz (1985-6)	Argentina, Bahrain, Brazil, Chili Egypt, Ghana, Hong Kong, India, Iran Republic of Korea, Kuwait, Mexico, Panama, Pakistan, Philippines, Singapore, Sri Lanka, Syria, Tunisia Venezuela, People's Republic of	Information occupations
. Li Sinan (1987)	China	Information industries and occupations

As regards occupations, the groupings include all professions involved in producing, processing and distributing information, and often information infrastructure industries. Depending on the authors, scientists, technicians, managers, foremen, consultants, educators and workers qualify as part of the information labour force. Others such as Gupta et al. (1974) and Debons et al. (1981) included only professions at a university or equivalent level.

Some authors, such as Porat and Rubin (1978) and the OECD (1981), use these industrial typologies to define a primary information sector, and occupational typologies to define a secondary information sector. According to Machlup (1962), these two means of approaching the information phenomenon are complementary.

3.1.1 Defining Key Concepts

Despite the enthusiasm that the information economy approach generated, it did give rise to extensive criticism, some of which concerned the definition of basic concepts and their consequences when analyzing the phenomenon.

a) Information and Information Activity

The greatest source of stimulation for further research in this field was by far the work done by Porat. His definitions of information and information activity served as references for subsequent studies, including work that drew on the OECD typologies:

> "Information is data that have been organized and communicated. The information activity includes all the resources consumed in producing, processing and distributing information goods and services"[1].

Porat recognized that distinguishing informational employment from other employment was no easy task. The informational emphasis of an activity is a question of degree:

> "Clearly all human endeavour contains some components of information processing. Without information processing, all cognitive functions would cease and there would be no human

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1 PORAT and RUBIN (1977, vol. I, p. 2).

activity. But that definition is useless. We are not saying that information workers deal exclusively in information and other kinds of workers never deal in information. Rather we assert that certain occupations are primarily engaged in the manipulation of symbols, either at a high intellectual content (such as the production of new knowledge) or at a more routine level (such as feeding computer cards into card readers).

And for other occupations, such as personal services or manufacturing, information handling appears only as an ancillary fashion. It is a distinction of degree, not of kind."[1]

Phillipe Lemoyne (1978), Roland Jouandet-Bernadat (1979) and the GAMMA Institute felt that this definition of information was too broad, since in a sense all human activity involves producing, processing and distributing symbols, knowledge or information. Work based on the information/knowledge economy is not immune to the trap of an imprecise definition of basic concepts. This has three major consequences.

First of all, the typologies put forth **include several industries and occupations with an ambiguous informational status**. For example, Porat and Rubin (1977) juggled with nearly thirty professional categories (see Table 29), including them in their inclusive definition of information activities, but deleting them from the exclusive definition. The OECD (1981, 1986) dealt with this dilemma by including or deleting these occupations on an arbitrary basis, due to a lack of time-budget studies[2].

The second consequence stems from the first. An **imprecise definition of the information activity reduces the reliability of the method**, in that many different typologies are drawn up based on similar definitions of key concepts. The composition of typologies varies according to the arbitrary choices of different researchers. This is the case for many studies that draw on Porat's work or that of the OECD, where various occupations such as technicians, artists, health specialists, foremen, etc. are treated differently.

The third effect involves the **heterogeneity among the information activities considered**. Information occupation typologies are often

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1 PORAT and RUBIN (1977, vol. I, p. 3).

2 OECD (1981, vol.I, p. 24).

lacking because there is no relation between the various activities considered, and because of differences in type or behaviour between information and non-information activities[1]. Note, for example, the OECD typologies (1981). In the industrial typology, the manufacture of telecommunications equipment and printing and publishing were included along with advertising services, education, furniture manufacturing, office supplies, pocket book and watch manufacture, textile grading and fishery inspection services. The occupational typology was similar, with computer specialists included along with secretaries, photographers, managers, shipping and receiving clerks, members of the clergy, sports trainers and instructors, judges and lawyers, actors, dieticians and physicians.

The concepts put forth by Porat also lead to **problems regarding terminology used**. According to Roland Jouandet-Bernadat (1979), the vocabulary employed is a source of confusion. On the one hand, the primary and secondary information sectors are defined, whereas the primary, secondary and tertiary sectors are terms generally employed in economics, more specifically in national accounting.

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[1] A member of the OECD team (1981), the Canadian economist George Warskett was particularly interested in the heterogeneity among information activities, which he felt was of the utmost importance. In economic analysis, factors or products are grouped according to the degree of technological or economic kinship that exists between the various elements that make up the aggregate, a similarity that distinguishes them from the other components not included in the group. This precaution means that a relatively uniform and autonomous reaction can be obtained, independent of the various components within the aggregate, as regards outside price and demand for goods. Warskett felt that the informational/non-informational dichitomy would be economically valid only if the preconditions for grouping existed. If they did not, a dissi-milar grouping of goods or services would be obtained, instead of a group of relatively homogenous products (Warskett, 1981, pp. 61-71).

Warskett (1984) tested the rate of substitution prevalent among the various components studied in the informational aggregate by comparing it with the non-informational rate of substitution. He was unable to make a significant distinction between informational and non-informational input, based on the results for the manufacturing sector. The economic justification of the information activity groupings therefore remains to be done.

One could be tempted to say that the primary information sector includes some secondary and tertiary sector activities and no primary sector activities, or that the secondary information sector does not include any industries in the primary, secondary or tertiary sectors. The meaning Porat gives to the word sector is also problematic. In economics, sector generally designates industries or a complex of industries. Here Porat uses it to describe both industries and occupations. Thus the primary information sector consists exclusively of industries, whereas the secondary information sector includes only occupations from all three economic sectors! Finally, Porat (1978), vol. 1, p. 24) uses the term activity to designate a concept that already exists, that of industrial cluster or production complex, whereas the term is used by statistics agencies to refer to a profession or industry.

b) Information: A Commercial Product

From a strictly economic standpoint, the conceptualization of information is no easy task. In fact, Machlup, Porat, etc. represented information as input (or an intermediate product) necessary for producing goods and services, and as output (or a final product) consumed by households, the government or external sectors. Information is viewed as a commercial product (goods and services) whose price is determined by supply and demand. Theoretically, optimum allocation of information goods and services occurs in a purely competitive market.

Often, however, the information-as-a-commercial-product analogy is difficult to maintain, because:

1) the information is not exactly a product, as it has no volume or mass and is often diffuse;

2) the information is not necessarily a scarce resource with limited substitutability. It can be multiplied, shared, openly accessed and lacking in recognized ownership of exclusive rights;

3) the transmitter of the information does not represent supply;

4) the receiver of the information does not represent demand;

5) there is often no price or cost to the consumer;

6) the price assumed by the user does not reflect the cost assumed by the producer and the transmitter.[1]

Many information goods and services are thus more characteristic of public goods than of commercial products. On the one hand, it is difficult to exclude from consumption users who do not pay for services ("free riders") while, on the other hand, their consumption is not affected by input from additional consumers. The existence of externalities, as well as the difficulties involved in defining or reinforcing rights of ownership, represent substantial limitations.

An additional difficulty in using this concept of commercial information is due to the fact that any information or information activity that is not traded, or that takes place outside a market context, is excluded from the field of analysis. Part of the information produced within the economy is thus ignored. Machlup tried getting around the problem by applying prices to these goods and services, as if the information were sold on the market. This approach by imputation is even more difficult when attempting to evaluate the market price of a government product that has no equivalent in the private sector, such as government planning services or social aid programs.

Porat (1977) and the OECD (1981) were interested in the question of information produced and consumed within public and private bureaucracies. In order to analyze this non-market information, they defined a secondary information sector dealing exclusively with the informational activities of bureaucracies. Unable to estimate them directly according to the value of their output, they focused on occupations. The results obtained do not, however, allow for comparison or the addition of results from the primary and secondary information sectors. In fact, these two sectors represent different aspects of information. The first sector covers "all the value added during the 'production' of goods and services sold on the markets, regardless of the nature (informational or non-informational) of the production activities themselves". The second sector considers "information activities involved in the 'production' of non-informational goods and services" (OECD, 1981 p. 42). Moreover, the primary information sector not only includes market industries, but also most government activities.

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[1] Based on Machlup (1980, p. 156) and Cleveland (1982).

In short, economists view information as a relatively recent subject for analysis. The schematization of information as a commercial product is, however, all the more relevant given that:

1) information is a product with limited substitutability, a scarce resource;

2) supply and demand are distinct economic entities;

3) product price is determined by the market, or can easily be compared to the price of similar products traded on the market;

4) the user pays for information, and the price fully covers production and distribution costs;

5) rights of ownership are readily defined, so that it is possible to exclude from consumption individuals who do not pay for information.

3.1.2 Informationalization of the Economy: Origins and Factors of Development

Over the years, those who adhered to the information economy approach identified a number of factors behind the origins and development of the informationalization of our economies.

According to Daniel Bell (1976), applications of theoretical and encoded knowledge, plus technological developments, gradually superseded empirical methods and traditional experimentation, leading to the increased specialization of labour. This provoked an increase in the number of scientists and technicians in organizations, and gave rise to the birth of so-called scientific industries (optics, polymers, informatics, electronics, etc.). These changes led to the growth of the information economy and the post-industrial society.

According to Serafini and Andrieu (1980), increased demand for information goods and services plus a low rise in the average productivity of information workers were the two major trends behind the growth of information employment in Canada. Other factors could also have been important: the government role in education, social assistance and health, private support for scientific and technical innovations, and the strong demand for education due to demographic factors.

According to the OECD (1981), the rise in the information labour force in the post-war years can be explained as follows:

1) 50% is due to increased employment in the service sector, coupled with a decrease in employment in the primary and most secondary sectors for the industrialized countries studied;

2) 25% is due to changes in the structure of employment in the tertiary sector, with increased employment in the fields of entertainment, personal services, transportation, communications, finance, insurance, real estate, business services and the public sector (education and health especially);

3) 25% is due to substituting non-information workers with information workers in the manufacturing sector. This is largely the result of an increase in government regulatory activities and supervision; the greater size of corporations; the growing complexity of the purchasing, financing and distribution functions; greater reliance on advertising and marketing in oligopolistic markets; and changes in productivity and the cost of work and capital factors (informational and non-informational).

According to Charles Jonscher (1983), the growth of information services was dependent on an increased number of scientists and technicians. Nonetheless, the labour force involved in research and development and education accounted for only 15% of the total number of information workers (in 1978). The growing government role in the economy was also cited, yet this accounted for only 10% of the information labour force. Households have obviously modified their consumption habits, increasingly opting for information services (television, entertainment, newspapers and periodicals, education, books, etc.). Although this expenditure increased rapidly in absolute terms, compared to the growth in total consumption it was quite slow. Jonscher saw the major factors as lying elsewhere: administration, co-ordination and organization activities, i.e. the managers, clerks, buyers, sellers, brokers, accountants, etc. who make up 80% of the information labour force. This demand for outside consultants, intermediaries, clerical personnel and supervisory personnel is a result of the tendency of technical progress to increase the complexity of the economic system, emphasizing specialization.

3.1.3 Informationalization as a Major Trend

Strictly speaking, information and information activities are not phenomena specific and exclusive to a number of 20th century societies. In a sense, all human activity is informational, as it is directed towards producing, transforming and distributing symbols, information, knowledge and skills. Moreover, individuals and organizations have always produced, processed and distributed knowledge and information. The social function of information activity is omnipresent, be it in the form of smoke signals, manuscripts, books or software. In that respect, the work of Innis (1950, 1951) on the history of communication is most eloquent.

The importance our society gives to these activities does not mean that we are unique. Theocratic ancient Egypt, Confucian China, the Athens of Pericles, Italy during the Renaissance (Florence, for example), Elizabethan England (Oxford and Cambridge, for example), and even modern-day Islamic Iran can also justly claim to have been or to be information societies[1]. They give or have given a central if not dominant role to the generation and dissemination of information.

What distinguishes ours from other societies is the structure of knowledge, the role of certain information activities, our institutions and their specific information needs (Melody, 1986). By associating the terms "knowledge" or "information" with the terms **scientific** and **technical**, researchers have been able to give a certain historical perspective to the informational phenomenon (Ithiel de Solla Price, 1963; Anderla, 1973). However, the phenomenon of scientific and technical information is still too specific to certain activities to be perceived as a movement transforming the economy as a whole.

With Machlup (1962), knowledge activity was approached from a new angle. He focused on knowledge industries and professions, regardless of whether or not their product was available on the market. In order to evaluate **non-market** knowledge activities, Machlup determined costs or prices based on similar **market** activities. The range of activities studied increased substantially, and a more structured analysis of a historical trend became possible. Daniel Bell (1973) used it as the basis for his descriptive analysis of the evolution from industrial society to post-industrial society.

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[1] See Balazs (1968), Valaskakis (1982a, p. 2) and Valaskakis (1982b, p. 22).

The research carried out by Porat and Rubin (1977) and the OECD (1981) employed Machlup's industrial occupational approach, using two sectors of information. They attempted to eliminate from the field of analysis a number of non-market information activities considered by Machlup, but kept the bureaucracies. Their work enjoys a wide audience and has given rise to any estimates of the phenomenon on international scale. Since the beginning of the century, information activities have increased in importance for both developed and developing nations.

These statistical data do not, however, allow us to validate the inevitability of the "agrarian economy - industrial economy - service economy - information economy" sequence of development. For the past twenty years in developing countries, the proportion of the active population working in industry, services and information has tended to increase, and the number of those employed in agriculture to consistently decrease. The rise in the informational segment of the labour force is generally not associated with a decline in the industrial portion, as is the case in Great Britain and in the U.S. (Katz, 1986). Moreover, the segment of the labour force working in industry in Australia, West Germany and Canada decreased by only 5% or less 1950 to 1980 (Katz, 1986 p. 242; Picot, 1986 p. 110). Several factors influence the sectoral displacement of labour, making the analysis of the sequence of development in various economies quite complex.

Analysis of the sequence of economic development means that special attention must be paid to certain factors of influence, such as the extent of industrialization and the level of industrial competitiveness and capitalization of production. In addition, it must be based on indicators of change, i.e. sectoral contributions not only to the labour force but also to GNP. A highly robotized, productive manufacturing sector could very well generate a large proportion of GNP, but lead to jobless growth (Valaskakis, 1982b, p. 25). Would such an economy be informational, post-industrial or neo-industrial? The sequence of development leading to an information economy requires further analysis.

Nonetheless, the work done by Machlup, Porat-Rubin and the OECD allows for a historical interpretation of a structural, market and non-market phenomenon whose importance has grown throughout this century. Is this historical perspective of informationalization indicative of future trends?

In that respect, it would be worthwhile reviewing the current and the future situation of factors that will stimulate the

informationalization of the economy (reviewed in the precedent section). For the moment, we would simply like to draw attention to certain processes that risk slowing down or even reversing growth of the phenomenon:

- the fact that in Canada and the U.S. jobs are created mainly by firms with less than 20 employees and that these firms could proportionately employ fewer information workers than large organizations;

- the growth in the proportion of the active population in Canada working in the tertiary sector slowed down considerably from 1971 to 1981, going from 47% in 1951 to 62% in 1971, but only to 66% by 1981 (Picot, 1986). According to the OECD (1981), the tertiary sector has to date accounted for 50% of the growth of information employment;

- the increased productivity of service and office workers due to new information technology, and eventual decrease in demand for this type of labour, with both informational and non-informational labour being substituted by informational capital;

- the decrease in demand for education services due to lower birth rate;

- the management of scarcity within public and private bureaucracies plus the increased government deficit, which has led to a reduction in size and staff, rationalization of operations, definition of new priorities, cuts in expenditure, increased reliance on sub-contracting and outside contractors, etc.

According to Shirley Serafini (1980, pp. 9-10, 17), the anticipated effect of new information technologies on total factor productivity, the elasticity of substitution between labour and capital and the relative costs of labour and capital call into question the growth observed in the past for most categories of informational employment. Moreover, problems of measuring the output of the secondary information sector and the productivity of informational labour indicate that Porat's two-sector method holds little promise for future research. She points to the importance of Warskett's research, which showed that informational manpower should not be aggregate with informational capital due to differences in behaviour (see Section 3.1.1 a).

In addition, the information economy approach is limited in that it groups together economic activities that exhibit remarkably different behaviour. From a technological standpoint, the future for some information industries such as the software industry looks extremely promising, whereas the future for others such as telegraph services is much less so. The same phenomenon, taking computer scientists and typographers as examples, can be observed among information professions. The lack of similarity in the nature and behaviour of the information activities studied also poses considerable limitations as regards using the typology for analysis and long-term forecasting.

In short, the information economy approach, as presented by Porat and the OECD, now appears to be a limited tool for analyzing activities that are indicative of future trends. In order for this "market or non-market information activity" concept to be indicative of the future, we feel that a certain number of modifications or distinctions must be made:

1) the economic terminology used in research on the information economy must be compatible with the meaning generally given those terms by economists;

2) the economic conceptualization of information must be deeper in scope in order to improve methods for estimating its importance and effectiveness;

3) the meaning of definitions of information and information activities must be restricted in order to accentuate similarity in the nature or behaviour of the activities studied (industries and occupations), so as to eliminate activities with an ambiguous informational status and increase the reliability of the method.

In order to satisfy this third requirement, we propose two distinct options:

The first implies a return to the typologies that are closer to the Platonic view or that of Daniel Bell, i.e. that information activities include only "professionals" and the industries in which they are found in significant number. By "professionals" we mean administrators, managers, scientists, engineers, physicians, financial experts, etc. In that respect, the information or knowledge economy is marked by an increase in the more educated work force and by the birth and development of "scientific" industries, since they call for more abstract knowledge. This

would include the chemical, pharmaceutical, computer, telecommunications, aeronautics, biotechnology, electronics equipment and scientific instruments industries, etc.

The second option, and the one we favour, restricts the range of activities considered by situating the information economy approach within a computerized society perspective. This calls for two premises:

- associating the concept of "market or non-market information activity" with more leading-edge technological terms such as "electronic", "digital", etc. This means **acknowledging the past and future impact of technological evolution on the growth of market information activities**. In that regard, Melody (1986) points out that the rapid institutionalization of information, i.e. the growth in information traded on the market, was largely made possible by technological developments and reductions in information processing costs.

- **believing that new information technologies will have a determining influence on the future of information activities and structural changes in the economy**. According to Cordell (1985, p. 133), there is no doubt that the process of acquiring, storing, representing, manipulating and distributing information is increasingly conducted by machines and networks of computers and microprocessors. This is a fundamental element to which Western society and the human race must adapt[1].

3.2 The Computerized Economy

We have termed the second current of research the "computerized economy" because much research emphasizes the production and distribution of computerized products within the economy, and the subsequent structural impact. Among the major contributors to this approach are Nora and Minc (1978), R. Jouandet-Bernadat (1979), the GAMMA Institute (1979, 1984) and the "Agence de l'Informatique" (1986).

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[1] We are not referring here to technological determinism, but to a major, non-exclusive factor of influence affec-ting the future of information activities. How technology interacts with social, economic and political spheres is also an important consideration.

3.2.1 The Technological Sphere Considered

Steam engine technology (18th century) and electric and internal combustion technologies (early 20th century) are generally viewed as the engines behind the first two industrial revolutions. Those who adhere to a 'computerization of the economy' approach saw a third such revolution, which they initially termed informatics. As research progressed, the technological sphere expanded to become telematics, "informediation", etc.

Marshall McLuhan (1964) was among the first to point out that "innovations in the field of electronic communications provoke structural mutations in our societies and constitute the real industrial revolution of our era"[1]. A number of neologisms were then created to take into account the technical progress made in informatics and communications. In 1978, a report published by Simon Nora and Alain Minc proposed the term "telematics", a hybrid of telecommunications and informatics. The trend in the U.S. was to lean towards the neologisms "compcommunications"[2] or "compunication"[3], i.e. combining the terms computer and communications. The French term gave priority to telecommunications over informatics, whereas the American terms favoured the opposite.

The work of Nora and Minc (1978) and R. Jouandet-Bernadat (1979) popularized the concepts of a telematics revolution and complex. Their typologies include industries and professions related to informatics and also to telecommunications.

Iris Fitzpatrick-Martin (1979) of the GAMMA Institute approached the issue of the third industrial revolution by creating another neologism, "informediation". This is perhaps the closest English translation of "informatisation". "Informediation" is the processing and transforming of information by means of the media, i.e. "high-technology computer and communication devices"[4]. Informediation results from the interaction of three major factors:

1) "technology-push": increased capacity, reduced costs and

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1 JOUANDET-BERNADAT, R. (1979), p. 4.

2 Idem.

3 NORA, S. and A. MINC (1978), p. 11.

4 VALASKAKIS (1979, p. 8).

miniaturization of informatics and communication equipment;

2) "demand-pull": the purchase of informatics and communications equipment by consumers, businesses, governments and the external sector, taking into account the fact that demand for these goods and services is generally price and income elastic;

3) the presence or absence of government policies.

A few years later, the GAMMA Institute (1984) reworked somewhat its definition of "informediation". It became the diffusion of information technologies in various human activities, i.e. production, distribution, consumption, etc. Within information technologies, the GAMMA Institute now includes CAD/CAM technology, robotics and automation. This extension of the research field of interest is motivated by the dynamics of microelectronics, the backbone of the innovation process that generates hybrid technologies and multiple applications when associated with complementary technologies (fiber optics, remote sensing, etc.). These technological hybrids render the range of technologies considered in the late 1970s somewhat obsolete.

In 1986 the "Agence de l'Informatique" announced that the barrier between electronisation and the digitization of information was obsolete, as the microprocessor was increasingly becoming an integral part of machinery, industrial equipment and consumer goods. Consequently, it is difficult to distinguish between industries and occupations related to "informatics" products. In addition, the potential for microprocessor applications and marketing are such that in the medium and long term, almost all industries and occupations will eventually be involved in producing, transforming and distributing computerized goods and services that incorporate one or more microprocessors.

In short, it is worthwhile expanding the definition of the technological sphere underlying this industrial revolution, distinguishing between "computer products", "computerized products" and "computerization products". This will not be easy, of course, as research on the computerized economy has so far been based on different definitions of the underlying technology or technologies. In fact, theoretical conceptualization of the "informatics", "telematics", "microelectronics", etc. revolutions remains closely tied to the technological possibilities prevalent at the time of study.

3.2.2 Driving Activities and User Activities

The computerized society approach distinguishes on the one hand activities that are at the source of the phenomenon and, on the other hand, activities that use products created by the driving industries.

For Nora and Minc (1979), occupations and industries involved in computer equipment and components, telecommunication goods and services and computer services and data bases were at the heart of the telematics product diffusion process. For Roland Jouandet-Bernadat (1979), the following are driving industries: "Office and Store Machinery Manufacturers", "Radio and Television Receivers Manufacturers", "Communications Equipment Manufacturers", "Radio and Television Broadcasting", "Telephone Systems Services", "Telegraph and Cable Services", "Computer Services", and "Radio, Television and Electrical Appliance Repair Services". Three occupation groups were determined as playing a driving role: "Systems Analysts, Computer Programmers and Related Occupations", "Office Machines and Electronic Data-processing Equipment Operators" and "Electronic and Related Communications Equipment and Operating Occupations, n.e.c.". No new typologies have since been put forth that take into account the expansion of the technological sphere studied by researchers.

As for user activities, relatively few studies have analyzed the diffusion of telematics products within professions and industries. Nora and Minc (1978) felt that banking, insurance, government administration (postal services and social security in particular) and offices would likely be affected most. R. Jouandet-Bernadat (1979) noted that ten industries employed driving professions at a greater rate than the Canadian average: insurance, non-electrical equipment manufacturing, financial institutions, communications, mineral fuels extraction, petroleum and coal products manufacturing, business services, provincial government administration, public utilities and the federal government administration. These observations were made for the year 1971. Since then, a few Canadian studies have been conducted on the industrial distribution of these new products: surveys done by CEGIR, G. Betcherman and K. McMullen (1987), M. Lefebvre and R. Loranger (1987), L. Lefebvre, E. Lefebvre and J. Ducharme (1987)

and the Canadian Federation of Small Businesses[1]. However, these authors based their work on questionnaires distributed to a sample group of respondents. The questions varied from one group to another, and the range of technological products considered varied from the simple use of computers to digitized machine tools, robots and the use of management, planning and production software. Quite often, results are difficult to compare between one study and another, and differences are sectorally aggregate[2].

No theory exists to date as to how informatics or telematics products are diffused within various economic sectors, nor are there any typologies available for keeping abreast of developments. Nonetheless, P.-A. Julien, J.-B. Carrière and L. Hébert (1988, pp.4-5) described a number of factors that come into play when a company adopts technological innovations. These explanatory variables are grouped into three categories:

1) features of the new technology
   - profitability and cost

2) features of the industry
   - rate of growth
   - competition

3) features of the company
   a) structural features
      - size
      - growth
      - availability of information

   b) management profile
      - age, education and training of executives or owner managers
      - the firm's technical ability

   c) organizational features
      - "complexity"
      - presence of "technological sentries" and "champions"
      - effective communication and co-ordination

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[1] This CFSB study was cited in "Les entreprises du Québec s'informatisent rapidement", Le Devoir, Tuesday February 9, 1988, p. 7.

[2] For markets of specific goods, private organizations such as Link, Evans Research and the Canadian Association of Informatics analyse sales by industry groupings.

As for professions affected by the computerization process, Raymond Panko (1985) focused on office occupations. His list of professions includes scientists, post-secondary level teachers, receptionists, office clerks, managers, health professionals, etc. Panko's study pointed out that it would be interesting to construct an occupational typology based on the workplace in order to analyze how the phenomenon developed within professional activities. The logical progression from this research would be to conduct similar studies for factories, points of sale, etc. According to the "Agence de l'informatique" (1986) however, traditional boundaries between the various workplaces are gradually blurring due to the introduction of technological innovations such as CAD/CAM, work stations, intelligent cash registers, point-of-sale terminals, etc.

In short, this distinction between driving activities and user activities remains interesting, even if research to date has not led to industrial and occupational typologies for interpreting a technological phenomenon that extends beyond the limits defined by telematics. It is worth taking a look at later research on this issue, without, however, taking this distinction for a panacea. The "Agence de l'Informatique" (1986) is of the opinion that some of the economic changes resulting from computerization might make this dichotomy less apparent, notably between driving industries and user industries. Four arguments are put forth:

1) firms from complementary industries (electronics, office equipment, machine tooling, telephone equipment, etc.) are massively involved in informatics products;

2) the business services industry has gradually started to offer informatics products;

3) user industries often become producers of informatics products: printing, publishing, banking, etc.

4) distribution networks are being redefined and are increasingly associated with informatics partners, particularly among major distributors of electrical appliances and electronics, and firms that distribute specific goods to a particular industry, sector or profession.

3.2.3 Computerization as a Major Trend

Researchers in this field usually seem to restrict the meaning of the word technology to an array of goods and equipment that have a certain number of common characteristics in design, operation and

field of application. This represents only part of the picture, for it reduces the term "technology" to "technical hardware". Human skills and technical know-how are excluded from the context of analysis ("disembodied technical change"), whereas goods and equipment that incorporate knowledge are alone retained ("embodied technical change"). According to de Bresson and Peterson (1987, pp. 1-7), the concept of "technology" designates a reality where tools and instruments are indissociable from human practice, know-how and objectives pursued their use.

Yet even sticking to this reductive meaning, the expression information technologies appears to be somewhat imprecise. The term could be employed to include obsolete goods such as the inkwell, punch cards, manuscripts, etc. Use of the term new information technologies would allow for exclusion of these elements, concentrating on what distinguishes our society technologically from previous ones and from certain contemporaries: "computerization", "telematization", "microcomputerization" or even the new "technologisation" of information.

Historically speaking, these changes are unique, a distinctive feature of the second half of the 20th century. Most researchers in this field, however, do not see it as a rupture with the past. This industrial revolution is a continuation of the historic process of industrialization that replaces human skills and aptitudes with machines, and human and animal strength with "inanimate" [1]energy. In that sense, the industrial redeployment generated by driving activities and their products has led some authors to speak of the neo-industrial society as opposed to the post-industrial society of Daniel Bell, since the manufacturing sector remains vital to the economy as a whole[2]. But are we really confronted with a new, significant industrial revolution, or with technological innovations that are specific to certain industries and areas of application? In the case of microcomputerization and "new information technologies" that would seem likely. In fact, these two technologies give rise not only to innovative products, but innovative procedures as well, in addition to having repercussions in outside industries and applications.

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[1] GAMMA (1984, p. 18).

[2] "Neo-industrial", from "neos" or new. "Post-industrial" implies a society succeeding an industry-based society. For further details, consult Valaskakis (1984).

By thus defining the scope of the technologies underlying the current industrial revolution, another problem arises, i.e. the growing difficulty in distinguishing computerization from automation or electronisation. It will soon be possible to integrate microprocessors into the manufacture of nearly all intermediate and final goods in the very near future. If we consider all the activities related to these "computerized" or "electronized" goods, the resultant typologies would mean that we would be obliged to consider nearly all occupations and industries as related to the phenomenon. Since aircraft, robot welders, toasters and dolls incorporate microcomputers, they are, like the computer, part of the "new information technologies".

This area of future technologies and applications must then be better defined in order to identify structural economic impact and address the concerns of researchers interested in office automation or computerization as initially defined. In that respect, the Agence de l'informatique (1986) has proposed an interesting area of research -- considering only products that process information digitally, i.e. products whose logic is not parametric or fixed in silicone, but which can be modified. This means, moreover, that only goods and services whereby the digital electronic processing of information constitutes the major function. Such an orientation would allow for the exclusion of digitally controlled machine tools and robots, used mainly in tooling, painting, welding, gluing, assembling, loading, handling, stacking, etc. This definition enables us now to distinguish between "computerized products" and "computerization products". Consequently, many activities related to electronisation and not to computerization in the strict sense would be excluded.

As for drawing up typologies of economic impact, the "Agence de l'informatique" (1986) notes a trend among user industries to offer informatics services. This relatively recent phenomenon, which for the moment is limited in scope, merits closer study[1]. At present it does not call into question the relevance of the driving activity/user activity duality. It would also be worthwhile drawing up other typologies of impact, for example among activities that can be substituted by new technology.

At this point, the few studies done on the diffusion of computerization products within industries and occupations limits

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[1] In Canada, management and accounting consultant firms are competing with computer services firms for software evaluation. See Kangur (1987).

the possibility of creating typologies of user activities based on reliable empirical data. It is important to pursue research in this area. The creation of occupational typologies based on the workplace in order to analyse the impact of computerized products is also complex. It might be better to draw up a list of user professions without making distinctions as to the workplace, given the difficulty of defining the standard office[1] and the eroding boundaries between the office, factory, warehouse, points of sale, home, etc. created by the introduction of computerization products.

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[1] Panko (1985) considers as office occupations those that re related to the workplace, be they classrooms, laboratories, hospitals, courts, recording and broadcasting studios, points of sale, warehouses, etc. A more conventional definition of the office would include only managers and administrators, executives, secretaries and typists, bookkeepers and accounting clerks, office equipment operators, data processors, receptionists and messengers. Yet even with this typology, sales and purchasing personnel, advisors and professional consultants (lawyers, economists, engineers, architects, etc.), government administrators and senior civil servants, etc. are excluded.

4. THE ELECTRONICALLY DIGITIZED INFORMATION ECONOMY -- ELEMENTS OF A CONCEPTUAL FRAMEWORK FOR ANALYSIS

The previous chapter outlined a number of difficulties involved in conceptualizing the process of change. In order to be of use in long-term studies, it is important that the conceptual approach satisfy certain requirements:

- the process studied must be
  . gradual and ongoing
  . historically unique
  . a leading-edge process

- its impact must be structural,

- the key concepts used in analysis must be precisely defined, and not change in meaning over time,

- the typologies of impact must include activities that are relatively homogenous in nature and/or behaviour.

Based on these elements and the above overview of the literature, we have drawn up the elements of a conceptual framework of analysis on the growth of computerization in our economies. This approach draws on research on the computerized economy and emphasizes the economic impact of computerization. This chapter will define the key concepts involved, present typologies of impacts and discuss problems involved in assessing impact.

4.1 Defining the Key Concepts Involved

Our approach focuses on leading-edge technologies and on the process of producing and introducing their applications throughout the economy. We focused on the concept of technology rather than information, and computerization rather than informationalization.

Four key concepts should be defined when establishing a premise for this approach: information, digitalization, new information technologies and the computerization of the economy.

Information is any representation of facts or ideas standardized in the form of words, digits, images or sounds so that they can be processed manually, vocally, mechanically, electronically, analogically, digitally, etc.[1].

Digitization of information is the conversion of information into digital form so that it can be processed (produced, transformed, stored, distributed, accessed) in the form of goods and services associated with new information technologies.

New information technologies refers to new technologies, i.e. informatics, telecommunications, optics and acoustics[2] and their "hybrids"[3], as well as specific applications as regards information processing. Electronic digitalization of information is the backbone[4] of the innovation process in this technological sphere. The analog processing of information is thus excluded from this area of study. Table 46 enumerates the major applications considered.

The **computerization of the economy** is the process of producing and distributing products that are the result of new information technologies. It leads to a restructuring of the economy by creating new products and production procedures, new activities, the substitution of certain activities, etc. In that sense, computerization is a continuation of the historical process of industrialization. This process has a deep and extensive impact on society due to the extensive interaction among the technological, industrial, economic, social and political spheres. Consequently, computerization is the major driving force in the gradual, ongoing process of change that has a structural impact on our economies. It distinguishes and will continue to distinguish our era and our society from others.

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1 This definition is based chiefly on FONTOLIET (1985, p. 95).

2 DESCHATELETS (1987, p. 4) includes information processing technologies as belonging to these four technologies.

3 The expression "hybrid technologies" is borrowed from AMESSE, LANOIE and LAMY (1984, p. 6).

4 The term "backbone" is borrowed from the same source as 3.

Table 46

Applications of New Information Technologies

- optic fibers and scanners;
- micro-electronic components: high density integrated circuits, programmable array logic (PAL), digital signal processors (DSP), specialized circuits, memory cards, etc.;
- computers and terminals: "non-intelligent" terminals, videotext, teletext, facsimile machines ("fax"), banking machines, "intelligent" cash registers, remote metering equipment, etc.;
- other equipment related to electronic publishing, computer graphics and videography (plotters, etc.);
- material and equipment associated with computer-tomography and ultrasonography;
- digital audio material and equipment (recognition and automatic synthesis of speech, digital recording and playback of music, etc.);
- micrographic material and equipment;
- floppy diskettes and laser cards;
- optic disks and playback equipment (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, erasable CD, etc.);
- software, software packages, expert systems;
- local and wide-area networks (LAN, WAN);
- interactive cable television material and equipment;
- digital telephone and cellular radio material and equipment;
- satellites and other remote sensing equipment;

4.2 Typologies to Assess Development of the Phenomenon

Previous typologies of information activities are marked by a definition that is very broad, resulting in a great lack of similarity among the industries and occupations considered, grouping together activities of vastly different output, technology and future prospects. Our typologies on the impact of computerization are defined in a more restrictive manner, with the result that the groupings of activities are more homogenous. Among the many economic impacts, three types in particular are foreseen: the emergence of driving activities, their replacement of certain activities, and the introduction of leading-edge products into the economy (Figure IV).

The following sections will review these typologies. The Appendix details the activities studied, their four-digit Standard Industrial Classification Codes, 1980 and Standard Professional Classification Codes, 1980, as well as the benefit of singling out certain components.

4.2.1 Driving Activities

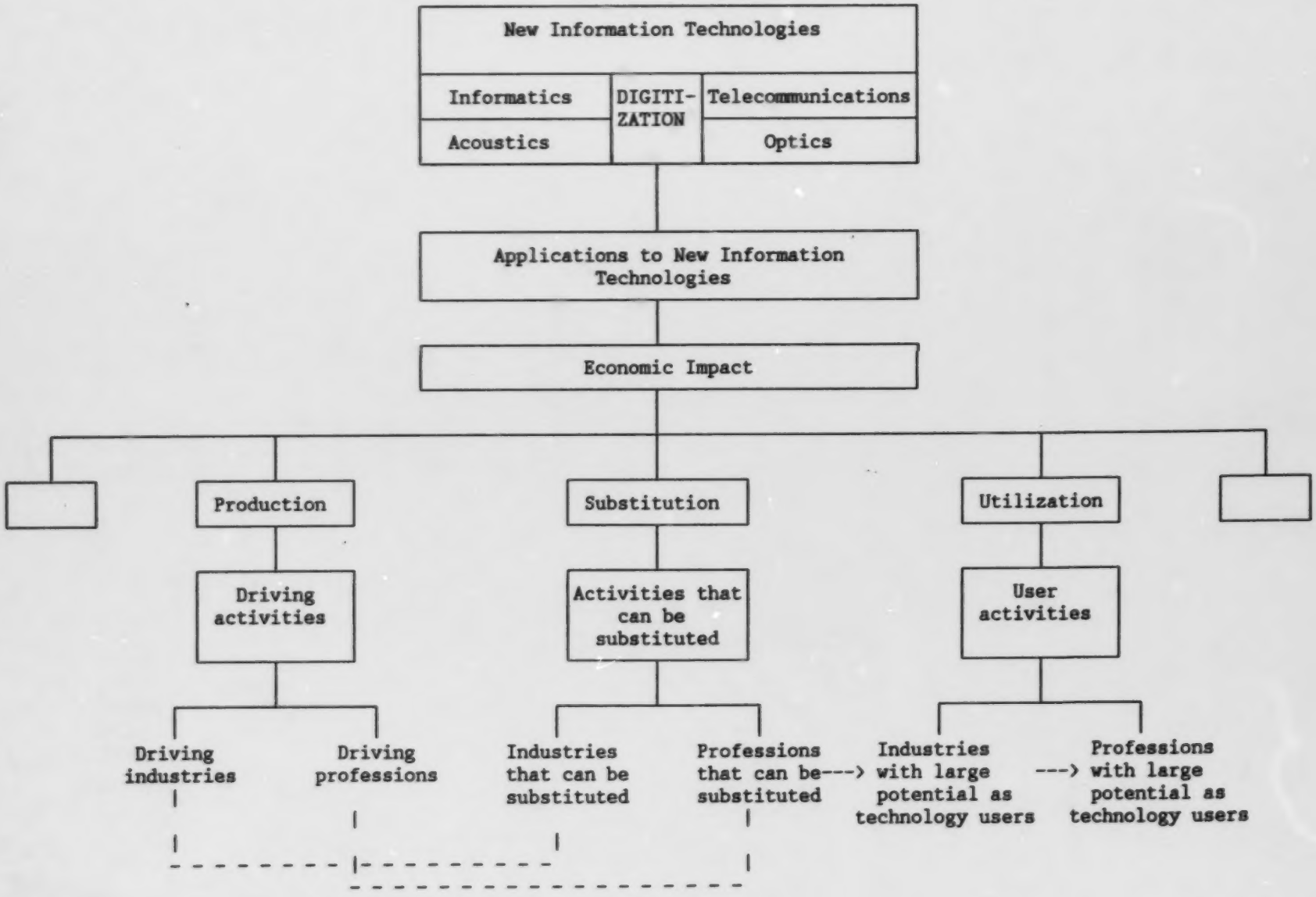
Our approach towards driving activities draws from the works of R. Jouandet-Bernadat (1979), J.-P. Legoff, A. Lapointe et al (1983), S. Black (1983) and A. Martin from the Department of Communications (1987). We shall first indicate activities related to the "electronic processing of information". We shall then isolate those that we consider to be driving and which are related to the "electronic digital processing of information". The driving activities are therefore directly stem from our definition of the leading-edge technological sphere, i.e. one where the electronic digitalization of information is at the heart of the process of technological innovation.

The **electronic processing of information** concerns any activity involved in producing, transforming, storing or distributing information by means of electronic support or equipment. The information thus processed may appear in an analog or digital form, or on film, transparencies, etc.

Industries involved in the electronic processing of commercial information are private, public and para-public firms primarily involved in offering the following in the market place:

- electronic products for producing, transforming, storing or distributing audio, visual or written information.

Figure IV
Typologies to Assess Development of the Phenomenon



---> Other conceptual links involved in drawing up typologies.

- services for electronically producing, transforming, storing or disseminating audio, visual or written information.

- auxiliary electronic information processing services[1] (sales and leasing, installation, maintenance, repair and consultation, including training) (Appendix A).

Industries in the primary sector and most industries in the secondary sector (including printing and publishing) are excluded, as are government administration and teaching, transportation and storage services, public utilities, the hotel-restaurant industry, employment and domestic services, financial intermediaries, insurance and real estate, most wholesale and retail services (including bookstores and art galleries), health services and social services, and entertainment and leisure (including theatre, performances and professional sports).

Electronic information processing professions include all paid employment positions involved mainly in:

- manufacturing, installing, maintaining, repairing or operating goods or equipment that electronically process audio, visual or written information;

- adapting to physical, human or organizational contexts goods and services that electronically process audio, visual or written information.

The goods and services in question are offered on the market or to beneficiaries[2], or are used within the organizations that produce them (Appendix D).

Excluded are occupations associated with the primary sector (farmers, horticulturists, livestock producers, fishermen and trappers, drillers, forestry workers and loggers), workers in manufacturing industries, machinists, workers specialized in assembling, manufacturing or repairing non-electronic products (wood, textiles, fur and leather, rubber and plastic, metal),

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1 The connotation of the term "technology" is that of C. de BRESSON and J. PETERSEN (1987, p. 3). The auxiliary services in question concern not only electronic goods, but also the workers who use them.

2 The term "beneficiaries" is used here in the sense of people with recourse to government services.

construction workers (except those involved in installing and repairing communications equipment), transportation personnel, packers, operators of fixed equipment and facilities, printers and related workers, service and sales personnel, members of the clergy, bookkeepers, accounting clerks, warehouse personnel, shippers and distributors, as well as most teachers, engineers, medical and health workers, literary and artistic professionals, workers in the natural, social and engineering sciences, directors, managers, administrators and related personnel.

Digital electronic processing of information concerns audio, visual and written information in digital form that is entirely processed by electronic information equipment.

Industries involved in the digital electronic processing of commercial information include private, public and para-public firms primarily involved in offering the following in the market place:

- goods for producing, transforming, storing or distributing audio, visual or written information using digital electronic equipment;

- services for producing, transforming, storing or distributing audio, visual or written information using digital electronic equipment;

- auxiliary digital electronic information processing services (trade, installation, repair, maintenance and consultation, including training) (Appendix B).

Compared to industries that electronically process information commercially available, activities excluded are those related to analog audio (radio, etc.), television and non-interactive cable television, telegraph services, photography, analog telephone communications, analog audio, musical instruments and most film and video activities.

Professions involved in the digital processing of information are paid employment positions involved mainly in:

- producing, installing, repairing and operating goods and equipment that process audio, visual and written information using digital electronic equipment;

- adapting to physical, human and organizational contexts goods and equipment that process audio, visual and written information using digital electronic equipment.

The goods and services in question are offered on the market or to beneficiaries, or are used within the organizations that produce them (Appendix E).

Compared to professions involved in the electronic processing of information, technologists and lab technicians (in the physical sciences and medicine) are excluded, as are photographers and operators of analog cameras, photo development workers, orchestra conductors and musicians, radio and TV repairmen, those who manufacture, assemble and repair radio and television sets and other equipment that employs analog electronics.

4.2.2 Activities that can be Substituted by New Technology

Driving activities were defined based on the hypothesis that electronic digitalization of information is at the heart of leading-edge technologies. The growth and impact of these computerization products within the economy results in a restructuring of industrial and professional activity. Growth of these driving activities leads to an eventual decline and/or redefinition of activities involving technologies that, strictly from a technological standpoint, are mature and could eventually be substituted. In that sense, our typologies of activities that can be substituted by new technology include industries and occupations that should experience the opposite fate of computerization driving activities, if they confine themselves to offering goods and services related to mature technologies[1].

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[1] Note that our typologies concern activities that can be technologically substituted by new technology. The future of these activities also depends on other factors. Some activities that can be substituted by new technology may resist the wave of innovation because of their ability to:

- upgrade their expertise and redefine a 'product mix' that focuses more on digital electronic processing technology. These activities are found mainly in auxiliary services that may be substituted technologically, for example retail stores, training consultants, etc.;

- adapt technological innovations to current products or production processes. These are mainly goods and services involved in information processing that may technologically be substituted, for example the use of microcomputers at

Information processing industries that can be substituted by new information technology are inferred from the typology of driving industries. They offer competitive products yet, technologically speaking, face different futures. Information processing industries that may be substituted by new technology include private, public and para-public firms that mainly offer the following in the market place:

- goods for producing, transforming, storing or distributing audio, visual or written information by means of technology that is being or will eventually be replaced by digital electronics;

- services for producing, transforming, storing and distributing audio, visual or written information by means of technology that is being or will eventually be replaced by digital electronics;

- auxiliary services related to traditional technologies (installation, maintenance, repair and consultation, including training) (Appendix C).

This list includes activities listed in the typology of industries involved in the electronic processing of information (Appendix A), minus the elements considered by the typology of industries involved in the digital electronic processing of information (Appendix B). Additions include printing and publishing industries, non-computerized postal and messenger services, book wholesalers and retailers, amusement and recreational services such as theatres, race tracks, arenas, museums and archives, botanical gardens and zoos. Although they do not produce non-digital electronic goods and services, these new additions highlight industries that offer products that compete with driving industries.

Information processing professions that can be substituted by new technology are defined based on the technological substitutions

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certain stages of the newspaper printing process;

- maintain reliable demand because of user habits or features of old products that are still viable, etc. This would include many entertainment and leisure services such as theatre, opera, sports and musical events, etc.;

- take advantage of tariff and non-tariff barriers, etc.

described in Table 47 and on the fact that these changes call into question the expertise of many professional categories, or at least could reduce demand for such. In some cases, the current state of technological possibilities could result in the decline of professional categories involved in technological goods that can be substituted by electronic processing goods. In other cases, tasks carried out by other professions could be totally or partially substituted by operations performed by electronic information processing goods or equipment, in particular typists vs word processors, tellers vs banking machines and debit cards, designers vs design software, telephone operators vs digital telephone systems, office clerks and bookkeepers vs accounting software and electronic mail services, inventory clerks vs automatic updating of inventory by "intelligent" cash registers, etc.

Our typology of professions that can be technologically substituted by new information technology includes paid employment positions involved mainly in:

- manufacturing, installing, maintaining and repairing equipment that may be technologically substituted by digital electronic information processing equipment;

- tasks that may be technologically substituted by digital electronic information processing products.

The goods and services considered are offered on the market or to beneficiaries within the organizations that produce them (Appendix F).

The first category includes occupations related to information processing equipment that can be technologically substituted by other electronic information processing goods and services. This includes the list of electronic information processing professions (Appendix D, Section 1), minus the list of digital electronic information processing professions (Appendix E, Section I).

The second category considers occupations for which many or all tasks could be technologically substituted by digital electronic information processing goods and equipment, that is occupations that can be readily computerized. This includes office employees, some technicians, various intermediaries who act as middlemen between the client and the goods and services as such (salesmen, buyers, hostesses, telephone operators, etc.), printers, typographers, telegraph operators, etc. This is the level at which the effects of the first wave of the computerization of the

Table 47

Technological Substitution of Various Professional Tasks

FROM TO TRADITIONAL TECHNOLOGIES	NEW INFORMATION TECHNOLOGIES
A) Collecting Information	
Verbal exchange	Optic scanners
Pencil and paper	Banking machines
	Debit cards/memory cards
	"Intelligent" cash registers
Typing	Diskettes and digital disks
Dictaphones	Electronic briefcases
Tape recorders	Digital video recorders
Digital audio tape	
Other automated data entry systems	
Visiting customers or beneficiaries	Microcomputers
Meters	Remote metering and other computerized data capture systems
On-site canvassing	Remote sensing
B) Bookkeeping, Analysis and Control	
Spreadsheets	Electronic spreadsheets
Cardex	Microcomputers
Pencil and paper	Accounting and statistical software: budget analysis, producing complex reports
Calculators	
Account books:	Transaction systems
- ledger	Management information systems integrated into accounting system: data bases compiling graphics and data bases
- payroll account	
- accounts receivable	
- accounts payable	
- inventory	
Financial, activity and management reports	Expert systems
Surveillance and control systems of personnel	Computerized control
Spreadsheets	Electronic spreadsheets
Radiography	Tomography and computer-assisted resonance spectroscopy

Table 47

Technological Substitution of Various Professional Tasks
(continued)

C) Filing and Archives

Administrative procedures	Optic disks
Filing cabinets	Disk filing systems
Paper documents	Data banks
Slides and transparencies	Videodisks, optic disks
Microfilm	Electronic micrography
Magnetic tape	Electronic filing

D) Communication and Duplication

Verbal communication	Synthetic voice
Conferences, trips	Computer-assisted
audio/video/teleconferences	
Overhead projectors	Videotext, videodisks
Pencil and paper	Electronic mail
Typing	Word and document processing
Agendas and memos	Electronic bulletin boards
Analog telephone	Digital and cellular
telephone	
Messenger and postal service	Electronic messenger service
Telegraph	Telex, teletex, telecopiers
Analog audio	Digital audio
Printing and publishing	Electronic publishing Laser printers, photocopiers
Photocopiers	and computer-assisted photo-composers
Drawing boards and tables	Computer graphics and computer-assisted design
Video	graphy
	Plotters

Source: Table based on work of P.-A. Julien and L. Hébert (1988, pp. 17-19) and I. Miles (1987).

workplace is felt (Dumas, Maurice and Deschênes, 1988, pp.46-65). Expert systems and other digital applications may significantly affect professionals and managers only at later stages of the growth and diffusion of these technologies.

4.2.3 Activities that are Major Users of Computerization Products

Drawing up typologies of activities that are major users of computerization products is a complex affair. On the one hand, some current applications of new information technologies can be used by nearly all industries or professions, be it electronic briefcases used in retail trade and sales, breakdown diagnostic software used by manufacturers and maintenance technicians, CD-ROM used by libraries and data technicians, "intelligent" cash registers used by cashiers, cellular telephones used by security guards, automated ticketing systems used by travel agents, etc. On the other hand, there are relatively few studies on the diffusion of these products within industry and occupational categories which allow for comparisons and at a sufficient level of disaggregation.

In order to approach the issue of industrial diffusion, we worked from the premise that applications of new information processing technologies are likely to interest for the most part industries and firms concerned with increasing labour productivity, and also firms and industries whose labour force consists to a large extent of occupations that could be replaced by digital electronic information processing goods and services, that is occupations that can be computerized[1].

This hypothesis led us to consider industries where the occupations listed in Appendix F, Section II predominate, i.e. occupations where many or all tasks could be technologically substituted by computerization products. In Canada, these are mainly found in the service sector in retail trade, warehousing, communications, financial institutions, insurance, real estate, business services, teaching, health services, social services and government. The Statistics Canada four-digit codes of industries and occupations will enable us to enumerate these activities in detail.

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[1] The amount of capital available, the level of industry competitiveness, the rate of market growth, the size of the firm, use of computer products as part of corporate strategy, etc. may also be variables that influence the introduction and impact of these products.

This industry grouping also includes user activities that, once the technology is mastered, could gradually offer digital electronic information processing services. The automated bank machines offered by banking institutions are a good example.

Based on occupations in the major user industries, we are able to draw up a list of occupations likely to become users of these products. The underlying hypothesis is that the introduction of applications of new information technology generally implies changes in a company's production process, affecting the nature of the tasks carried out and how the work is organized. These changes do not involve only occupational categories that can be substituted by new technology, but also related occupations as well. The computerization process gradually takes hold in other departments and professional categories within the firm so that communications, management, control and working methods are standardized. Occupations that are major users of computerization products are found within industries that are major users, the very industries that have occupations that can be technologically substituted by computerization products, and that are interested in increasing productivity. Statistics Canada could provide us with occupation/industry matrix in order to draw up a detailed list of occupations that are major users.

4.3 Problems in Measuring and Classifying Activities

The fact that computerization is technologically and economically new, a booming phenomenon that is in constant flux, not only increases the difficulty in conceptualizing the phenomenon and its impact, it means that measuring it by means of traditional classifications of activities is also difficult. In order to analyze the phenomenon and evaluate these difficulties, we have drawn up industrial and occupational typologies based on the fourdigit Standard Industrial Classification Codes (SIC 1980) and Standard Occupation Classification Codes (SOC 1980). In doing so, certain limitations regarding these official groupings of activities became apparent.

The major drawback is due to the fact that the groupings of activities are not sufficiently defined according to the technological nature of the good or service produced by the industry, or according to how the occupations are related to the various technologies. Activities that are related to electronic goods and services do not necessarily have codes that distinguish them from non-electronic goods and services, or that allow for a

distinction to be made between analog electronics activities and digital electronics activities. Industrial code 3994, for example, includes wind instruments, analog disks, digital cassettes and disks. Occupation code 4113 includes telex operators and typists/clerks.

The second limitation is related to the relative dimension criterion used by Statistics Canada. For an activity to be considered distinct, i.e. that it be given its own code, its production must be "substantial enough to ensure its statistical usefulness for classification"[1]. This criterion is very logical in drawing up national classifications of economic activities. However, it limits the opportunity of following the birth and growth of new activities, and the growing importance of certain activities that are grouped with other activities under the same code. This means that some impacts of computerization may be hidden. Take for example the emergence of computerized data banks or data bank brokers and experts.

Another limitation of the Statistics Canada classifications becomes apparent when studying the restructuring that occurs with a phenomenon as dynamic as computerization. In fact, some activity groupings now correspond less closely to the specialization and coverage criteria used by Statistics Canada and this trend is apt to continue[2]. Industries that produce goods and services in separate markets increasingly compete within the same markets, particularly informatics and telecommunications industries. The same phenomenon can be observed for occupations, where professionals from different disciplines (and codes) compete in identical markets, such as psychologists, computer specialists, engineers, architects specialized in ergonomics, and librarians and computer scientists with expertise in computerized data banks.

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1 Statistics Canada (1980, p. 18).

2 Statistics Canada defines the specialization criterion as follows: "The production of the type of good or service that characterizes a certain industrial category must represent the major portion of overall production of the units listed under this industrial category". The coverage criterion implies that the industrial category groups together "units that produce the major portion of the goods or services that characterizes that category". See Statistics Canada (1980, p. 18).

Given these limitations, it is at times difficult to distinguish driving activities from activities that may be replaced by new technology and, consequently, the resultant user activities. The economic impacts of computerization are not apparent, for activities listed within the same industrial or occupation code have, technologically speaking, different future prospects either because the activities are too recent to be listed under separate codes, or because the restructuring of activities takes place outside the groupings listed. Hidden impact includes:

- **the birth and development of certain driving activities.**
  E.g.: computerized postal services listed under industrial code 4841, or automatic distributors or automated vending machines listed under occupation code 8589;

- **the substitution of certain activities by other activities.**
  E.g.: manufacture of analog radio receivers, tape recorders and turntables replaced by the manufacture of compact disk players and digital audio tapes under industrial code 3341, or typewriter repairmen replaced by digital processing equipment technicians under occupation code 8585;

- **defining new groupings of activities that offer chiefly driving goods and services of a similar nature.**
  E.g.: informatics and telecommunications goods and services, or information brokers, professionals listed under librarians (2351) and computer scientists (2183).

In short, estimating the economic impact of computerization on the basis of the Statistics Canada classifications entails a number of difficulties. First, it would appropriate be to consult Statistics Canada in order to assess the possibility of isolating certain activities within the codes or regrouping them in a different manner. If more detailed groupings are not possible, certain codes included in our typologies should perhaps be excluded or kept. This would mean introducing a certain bias, i.e. keeping irrelevant activities within categories that list mainly activities of interest, or ignoring activities of interest because the category consists mainly of irrelevant activities. We must then determine whether the concessions made for the purposes of precision allow for clearly and significantly differentiating between electronic activities and digital activities, and between driving activities and activities that can be technologically substituted by computerization products.

If that is not possible, studies on the issue done by private firms should be considered, for example those conducted by Evans Research Corporation, Link and CIPS. We should, however, restrict ourselves to a smaller and less detailed amount of information than that available in the Statistics Canada census data. Data from private organizations could also be used in combination with data from Statistics Canada in order to determine the driving activities (and indirectly, activities that can be technologically substituted by computerization products included in the various categories. To start with, we must know, however, the year the computerization products were first produced and sold, as well as their rate of their growth and, ideally, the occupation affected.

CONCLUSION

This selective review of the literature conducted in the first two chapters compared various industrial and occupational typologies in relation to two major areas of research, i.e. the information economy and the computerized economy. We focused in particular on the research done by Machlup, Porat, the OECD and Rubin on the information economy, and the work done by Nora and Minc, Jouandet-Bernadat and the "Agence de l'informatique" on the computerized economy. Substantial differences appeared regarding the activities considered by the various typologies.

Chapter 3 analyzed in a more systematic manner the basis and limitations of these approaches, reviewing definitions of the phenomenon, its causes and the factors behind its development, the key concepts employed and the relevance of these theoretical tools for analysis and long-term forecasting. For each of these trends, a number of conceptual problems were identified. Consequently, it seemed more appropriate to analyze the economic impact of new information technologies by focusing on the computerized society. Chapter 4 thus proposed elements of a conceptual framework for this analysis. It approached the computerization of the economy by concentrating on the phenomenon that is at the heart of the process of change, the electronic digitalization of information. Typologies of impact were then drawn up.

The change that our society is currently undergoing appears to be a new, booming and explosive phenomenon. It is therefore difficult to describe it conceptually or construct tools for measuring its growth and impact. We hope that this exploratory research has been useful for those involved in related research. This analytical framework should be expanded further. In that regard, a follow-up report should focus in particular on:

1) making distinctions within new information technologies between enabling applications or "structural" applications, that is those that have an impact on the production process and on industrial structures and strategies;

2) documenting and analyzing in greater depth the process of industrial and professional restructuring, testing especially the hypothesis that a digital electronic information network (or sub-network) is being created, one linking electronics, informatics, electronic equipment and machinery, and communications industries;

3) documenting and analyzing in greater depth the way in which computerization products are introduced into industrial and professional activities;

4) consulting Statistics Canada on the possibility of alleviating the problem with activity groupings encountered when attempting to estimate the various facets of computerization.

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APPENDICES

APPENDIX A

INDUSTRIES INVOLVED IN THE ELECTRONIC PROCESSING OF COMMERCIALLY AVAILABLE INFORMATION

I. ELECTRONIC INFORMATION PROCESSING EQUIPMENT

28. Printing, Publishing and Allied Industries (some)

281 Commercial Printing Industries (some)
- 2811 Business Forms Printing Industries (1)
- 2819 Other Commercial Printing Industries (1)

282 Platemaking, Typesetting and Bookbindery Industries (some)
- 2821 Platemaking, Typesetting and Bookbindery Industries (1)

283 Publishing Industries (some)
- 2831 Book Publishing Industry (1)
- 2839 Other Publishing Industries (1)

284 Combined Publishing and Printing Industries (some)
- 2841 Newspaper, Magazine and Periodical (Combined Printing and Publishing) Industry (1)
- 2849 Other Printing/Publishing Industries (1)

33. Electrical and Electronic Products industries (some)

334 Record Player, Radio and Television Receiver Industry
- 3341 Record Player, Radio and Television Receiver Industry (2)

335 Communications and Other Electronic Equipment Industries
- 3351 Télecommunications Equipment Industry
- 3352 Electronic Parts and Components Industry (3)
- 3359 Other Electronics and Communications Equipment Industries (4)

336 Office, Store and Business Machine Industries
- 3361 Electronic Computing and Peripherical Equipement Industry
- 3362 Electronic Office, Store and Business Machine Industry

39. Other Manufacturing Industries (some)

391 Scientific and Professional Equipment Industries (some)
- 3911 Indicating, Recording and Controlling Instruments Industry
- 3912 Other Instruments and Related Products (5)

399 Other Manufactured Products (one)
- 3994 Sound Recording and Musical Instruments

II. ELECTRONIC INFORMATION PROCESSING SERVICES

48. Communications Industries

481 Telecommunication Broadcasting Industries
- 4811 Radio Broadcasting Industry
- 4812 Television Broadcasting Industry
- 4813 Combined Radio and Television Broadcasting Industry
- 4814 Cable Television Industry

482 Telecommunications Carriers Industry
- 4821 Telecommunications Carriers Industry (Including Cellular Telephones)

483 Other Telecommunications Industries
- 4839 Other Telecommunications Industries

484 Postal and Courier Service Industries
- 4841 Postal Service Industry (6)

77. Business Services

772 Computer and Related Services (some)
- 7721 Computer Services (7)

779 Other Business Services (some)
- 7796 Duplicating Services
- 7799 Other Business Services n.e.c. (8)

86. Health and Social Service Industries (several)

868 Medical and Other Health Laboratories (some)
8682 Radiological Laboratories
8683 Combined Medical and Radiological Laboratories (9)

96. Amusement and Recreational Service (some)

961 Motion Picture, Audio and Video (some)
9611 Motion Picture, Audio and Video Production (some)
9613 Motion Picture Laboratories and Video Production Facilities
9614 Sound Recording Services

962 Motion Picture Exhibition
9621 Regular Motion Picture Theatres
9622 Outdoor Motion Picture Theatres
9629 Other Motion Picture Exhibition

99. Other Service Industries (some)

993 Photographers
9931 Photographers

999 Other Services n.e.c. (some)
9999 Other Services n.e.c. (10)

III. AUXILIARY ELECTRONIC INFORMATION PROCESSING SERVICES

33. Electrical and Electronic Products Industries

335 Communication and Other Electronic Equipment Industries
3359 Other Electronic and Communication Equipment (11)

57. Machinery, Equipment and Supplies Industries, Wholesale (some)

574 Electrical and Electronic Machinery, Equipment and Supplies, Wholesale (some)
5743 Electrical Machinery, Equipment and Supplies, Wholesale

579 Other Machinery, Equipment and Supplies, Wholesale (some)
5791 Office and Store Machinery, Equipment and Supplies, Wholesale
5792 Service Machinery, Equipment and Supplies, Wholesale (12)
5793 Professional Machinery, Equipment and Supplies, Wholesale (4)

59. Other Products Industries, Wholesale (some)

595 Photographic Equipment and Supplies, Musical Instruments and Accessories, Wholesale
5951 Photographic Equipment and Supplies, Wholesale (13)
5952 Musical Instruments and Accessories - Wholesale (14)

62. Household Furniture, Appliances and Furnishings Industries, Retail (some)

622 Household Furniture Stores
6221 Appliance, Television, Radio and Stereo Stores (15)
6222 Appliance, Television, Radio and Stereo Stores, Retail
6223 Appliance, Television, Radio and Stereo Repair Shops

65. Other Retail Store Industries (some)

655 Musical Instruments Stores and Records Stores
6551 Musical Instruments Stores(16)
6552 Record and Tape Stores

657 Camera and Photographic Supply Stores
6571 Camera and Photographic Supply Stores (17)

659 Other Retail Stores (some)
6599 Other Retail Stores n.e.c. (18)

77. Business Service Industries (some)

772 Computer and Related Services
7721 Computer Services (19)
7722 Computer Equipment Maintenance and Repair

773 Accounting and Bookkeeping Services (some)
7731 Offices of Chartered and Certified Accountants (20)
7739 Other Accounting and Bookkeeping Services (20)

774 Advertising Services (some)
7742 Media Representatives (21)

775 Architectural, Engineering and Other Scientific and Technical Service (some)
7751 Offices of Architects (20)
7752 Offices of Engineers (20)

777 Management Consulting Services (some)
7771 Management Consultant Services (20)

96. Amusement and Recreational Services (some)

961 Motion Picture, Audio and Video Production and Distribution (some)
9611 Motion Picture and Video Distribution
9619 Motion Picture, Audio and Video Services

99. Other Service Industries (some)

991 Machinery and Equipment Rental and Leasing Services
9912 Audio-visual Equipment Rental and Leasing
9913 Office Furniture and Machinery Rental and Leasing (22)
9919 Other Machinery and Equipment rental and Leasing (23)

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(1) only electronic publishing considered, if found within these categories.

(2) includes videodisk and optic disk production (CD-ROM, CD-WORM, CD-I, CD-V, audio CD, etc.).

(3) these goods are included because their basic function is to electronically process information.

(4) only wholesale trade in electronic machinery and equipment for radiography, laboratory instruments and measuring apparatus considered, plus professionals who process information electronically.

(5) only electronic goods considered (digital, quartz, etc.).

(6) only electronic postal services that are offered on the market were considered.

(7) includes producers and users of data bases and related consultants. Consultation, rental and leasing services were isolated and listed under Category III - Related Electronic Information Processing Services.

(8) only electronic information services included in address and mailing list services, typing, statistical sampling, graphics and design, economic information, cataloguing, telephone solicitation and translation services were considered.

(9) laboratories that mainly use electronic information equipment were isolated.

(10) freelance radio and television personnel and press clipping services, conference speakers and freelance editors who offer mainly electronic services were isolated.

(11) electronic equipment repair and checking services were isolated from other activities in this category.

(12) wholesale film and cinema equipment and supplies (reproduction, development and duplication, as well as projection), plus automated banking machines were isolated.

(13) wholesale film projection and electronic photography equipment, material and accessories were isolated.

(14) wholesale trade in non-electronic musical instruments eliminated.

(15) includes only retail trade in radio and television sets and stereo equipment.

(16) retail trade in non-electronic musical instruments eliminated.

(17) anything concerning retail trade in non-electronic photographic goods eliminated.

(18) retail trade in audio goods isolated.

(19) only consultation services retained.

(20) only those involved in software evaluation and office automation consultation (layout, training, feasibility and implementation studies, etc.) were included.

(21) only representatives of the electronic media considered.

(22) excludes rental of non-electric office machinery and furniture.

(23) rental of medical equipment for analysis and diagnosis, and of electronic photographic equipment, was isolated.

APPENDIX B

INDUSTRIES INVOLVED IN DIGITAL ELECTRONIC PROCESSING OF COMMERCIALLY AVAILABLE INFORMATION

I. DIGITAL ELECTRONIC INFORMATION PROCESSING EQUIPMENT

28. Printing, Publishing and Allied Industries (some)

281 Commercial Printing Industries (some)
2811 Business Forms Printing Industries (1)
2819 Other Commercial Printing Industries (1)

282 Platemaking, Typesetting and Bookbindery Industries (some)
2821 Platemaking, Typesetting and Bookbindery Industries (1)

283 Publishing Industries (some)
2831 Book Publishing Industry (1)
2839 Other Publishing Industries (1)

284 Combined Publishing and Printing Industries (some)
2841 Newspaper, Magazine and Periodical (Combined Printing and Publishing) Industry (1)
2849 Other Printing/Publishing Industries (1)

33. Electrical and Electronic Products industries (some)

334 Record Player, Radio and Television Receiver Industry
3341 Record Player, Radio and Television Receiver Industry (2)

335 Communications and Other Electronic Equipment Industries
3351 Telecommunications Equipment Industry (3)
3352 Electronic Parts and Components Industry
3359 other Electronics and Communications Equipment Industries (4)

336 Office, Store and Business Machine Industries
3361 Electronic Computing and Peripherical Equipement Industry
3362 Electronic Office, Store and Business Machine Industry (5)

39. Other Manufacturing Industries (some)

391 Scientific and Professional Equipment Industries (some)
3912 Other Instruments and Related Products (6)

399 Other Manufactured Products (one)
3994 Sound Recording and Musical Instruments (7)

II. DIGITAL ELECTRONIC INFORMATION PROCESSING SERVICES

48. Communications Industries (some)

481 Telecommunication Broadcasting Industries
4814 Cable Television Industry (8)

482 Telecommunications Carriers Industry (some)
4821 Telecommunications Carriers Industry (9)

483 Other Telecommunications Industries (some)
4839 Other Telecommunications Industries (10)

484 Postal and Courier Service Industries (some)
4841 Postal Service Industry (11)

77. Business Services (some)

772 Computer and Related Services (some)
7721 Computer Services (12)

779 Other Business Services (some)
7799 Other Business Services n.e.c. (13)

86. Health and Social Service Industries (several)

868 Medical and Other Health Laboratories (some)
8682 Radiological Laboratories (14)
8683 Combined Medical and Radiological Laboratories (14)

96. Amusement and Recreational Service (some)

961 Motion Picture, Audio and Video (some)
9611 Motion Picture, Audio and Video Production (15)
9613 Motion Picture Laboratories and Video Production Facilities (16)
9614 Sound Recording Services (17)

99. Other Service Industries (some)

999 Other Services n.e.c. (some)
9999 Other Services n.e.c. (18)

III. AUXILIARY DIGITAL ELECTRONIC INFORMATION PROCESSING SERVICES

33. Electrical and Electronic Products Industries

335 Communication and Other Electronic Equipment Industries
3359 Other Electronic and Communication Equipment (19)

57. Machinery, Equipment and Supplies Industries, Wholesale (some)

574 Electrical and Electronic Machinery, Equipment and Supplies, Wholesale (some)
5743 Electrical Machinery, Equipment and Supplies, Wholesale (20)

579 Other Machinery, Equipment and Supplies, Wholesale (some)
5791 Office and Store Machinery, Equipment and Supplies, Wholesale (21)
5792 Service Machinery, Equipment and Supplies, Wholesale (22)
5793 Professional Machinery, Equipment and Supplies, Wholesale (23)

59. Other Products Industries, Wholesale (some)

595 Photographic Equipment and Supplies, Musical Instruments and Accessories, Wholesale
5952 Musical Instruments and Accessories - Wholesale (24)

62. Household Furniture, Appliances and Furnishings Industries, Retail (some)

622 Household Furniture Stores
6221 Appliance, Television, Radio and Stereo Stores (25)
6222 Appliance, Television, Radio and Stereo Stores, Retail (26)
6223 Appliance, Television, Radio and Stereo Repair Shops (27)

65. Other Retail Store Industries (some)

655 Musical Instruments Stores and Records Stores (some)
6552 Record and Tape Stores (28)

77. Business Service Industries (some)

772 Computer and Related Services
7721 Computer Services (29)
7722 Computer Equipment Maintenance and Repair

773 Accounting and Bookkeeping Services (some)
7731 Offices of Chartered and Certified Accountants (30)
7739 Other Accounting and Bookkeeping Services (30)

775 Architectural, Engineering and Other Scientific and Technical Service (some)
7751 Offices of Architects (30)
7752 Offices of Engineers (30)

777 Management Consulting Services (some)
7771 Management Consultant Services (30)

96. Amusement and Recreational Services (some)

961 Motion Picture, Audio and Video Production and Distribution (some)
9612 Motion Picture and Video Distribution (31)
9619 Motion Picture, Audio and Video Services (32)

99. Other Service Industries (some)

991 Machinery and Equipment Rental and Leasing Services
9912 Audio-visual Equipment Rental and Leasing (33)
9913 Office Furniture and Machinery Rental and Leasing (34)

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* As users of digital electronics begin designing and offering digital services, this list of industries will be updated. Attention should be paid to technological and economic developments, particularly as regards goods and services related to film and television (fiber optics, high definition screens, interactive cable television, etc.), financial institutions, consumer and commercial credit institutions (automated banking machines, etc.), and teaching and training that involves tactile screen video, optic disks and remote teaching.

(1) only electronic publishing considered.

(2) excluded are radio and television sets, tape (audio and video cassettes) and vinyl records. Only equipment and parts used in recording or playback by means of videodisks, optic disks (CD-I, CD-V, audio CD, CD-ROM, CD-WORM and, eventually, erasable optic disks) were considered, as well as digital recording and duplicating equipment for sound and video (used especially in the film industry).

(3) excludes telegraph and analog telephone equipment, but cellular telephone equipment is included.

(4) excludes the repair and checking of electronic equipment, which is listed under Related Digital Information Processing Services.

(5) excludes scales, balances and cash registers that are not connected to a computer.

(6) includes only instruments and apparatus used in engineering, geophysics, medicine and radiography that digitally process information.

(7) includes only digital video and sound production and recording, video disks, optic disks (CD-ROM, CD-WORM, CD-I, CD-AUDIO, CD-V, DV-I and, eventually, erasable optic disks) and digital audio tapes. Excluded are tapes (audio cassettes, analog video cassettes, etc.), vinyl records and musical instruments.

(8) includes only interactive cable television.

(9) excludes wire or radio telegraph services, but includes cellular telephones, videotex, etc.

(10) only digital music or television services considered.

(11) only electronic postal services considered.

(12) producers, users and consultants working with data bases, computer graphics, holography and electronic publishing are to be considered within this or other categories. List consultation, rental and leasing services under III - Related Digital Information Processing Services.

(13) electronic and digital services included in address and mailing list services, typing, word processing, statistical sampling, graphics and design, economic information, cataloguing, telephone solicitation and translation services were isolated.

(14) laboratories that mainly use digital electronic sensing equipment were isolated.

(15) only digitally processed film and video production considered (video disks, DV-I, CD-V).

(16) only the processing and duplication of digitally processed films and videos considered (video disks, DV-I, CD-V).

(17) only digital recording of sound and images considered.

(18) only freelance editors and press clipping services that offer digital information processing considered.

(19) only repair and checking of electronic equipment that digitally processes information considered.

(20) only services related to digital information processing equipment considered, such as computers, peripherals, data processing equipment, digital communication infrastructures and digital equipment for recording and duplicating sound and video.

(21) only word processing equipment, electronic cash registers, point- of-sale terminals, calculators, and address machines considered.

(22) only digital film equipment/material and banking machines considered.

(23) only digital equipment and material used in laboratories, medicine, radiography and geophysics considered.

(24) only CD-ROM, CD-WORM, CD-I, CD-V, erasable optic disks and video disks considered.

(25) firms involved mainly in retail trade in equipment and material for digital production or duplication of sound or video were isolated, i.e. video disks, optic disks (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, DV-I and erasable optic disks) and digital audio tapes.

(26) only firms involved mainly in retail trade in equipment and material for digital production or duplication of sound or video were isolated, i.e. video disks, optic and disks (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, DV-I and erasable optic disks).

(27) only repair of material and equipment included in (25) and (26) was isolated.

(28) only video disks, optic disks (CD-ROM, CD-WORM, CD-I, CD-V, DV-I and erasable optic disks) and digital audio tapes considered.

(29) only consultation, sales, leasing and rental related to data bases, informatics, computer graphics, electronic publishing, holography, etc. considered.

(30) isolates software evaluators and office automation consultants (layout, training, feasibility and implementation studies, etc.).

(31) only distribution or trade in digitally processed CD-V, film and video considered.

(32) only ticketing agents and digital film and video libraries (video disks, CD-V, DV-I) considered.

(33) only rental of digital sound and video equipment considered.

(34) only rental of electronic calculators considered.

APPENDIX C

COMMERCIALLY AVAILABLE INFORMATION PROCESSING INDUSTRIES THAT CAN BE SUBSTITUTED BY NEW TECHNOLOGY

I. INFORMATION PROCESSING EQUIPMENT THAT CAN BE SUBSTITUTED

28. Printing, Publishing and Allied Industries (some)

281 Commercial Printing Industries (some)
- 2811 Business Forms Printing Industries (1)
- 2819 Other Commercial Printing Industries (1)

282 Platemaking, Typesetting and Bookbindery Industries (some)
- 2821 Platemaking, Typesetting and Bookbindery Industries (1)

283 Publishing Industries (some)
- 2831 Book Publishing Industry (1)
- 2839 Other Publishing Industries (1)

284 Combined Publishing and Printing Industries (some)
- 2841 Newspaper, Magazine and Periodical (Combined Printing and Publishing) Industry (1)
- 2849 Other Printing/Publishing Industries (1)

33. Electrical and Electronic Products industries (some)

334 Record Player, Radio and Television Receiver Industry
- 3341 Record Player, Radio and Television Receiver Industry (2)

335 Communications and Other Electronic Equipment Industries
- 3351 Telecommunications Equipment Industry (3)
- 3352 Electronic Parts and Components Industry (4)
- 3359 Other Electronics and Communications Equipment Industries (5)

336 Office, Store and Business Machine Industries (some)
- 3362 Electronic Office, Store and Business Machine Industry (6)
- 3369 Other Office, Store and Business Machine Industry

39. Other Manufacturing Industries (some)

391 Scientific and Professional Equipment Industries (some)
3911 Indicating, Recording and Controlling Instruments Industry
3912 Other Instruments and Related Products (7)

399 Other Manufactured Products (one)
3994 Sound Recording and Musical Instruments (8)

II. INFORMATION PROCESSING SERVICES THAT CAN BE SUBSTITUTED BY NEW INFORMATION TECHNOLOGY

48. Communications Industries (some)

481 Telecommunication Broadcasting Industries
4811 Radio Broadcasting Industry
4812 Television Broadcasting Industry
4813 Combined Radio and Television Broadcasting Industry
4814 Cable Television Industry (9)

482 Telecommunications Carriers Industry
4821 Telecommunications Carriers Industry (10)

483 Other Telecommunications Industries
4839 Other Telecommunications Industries (11)

484 Postal and Courier Service Industries (some)
4841 Postal Service Industry (12)
4842 Courier Service Industry

77. Business Services (some)

779 Other Business Services (some)
7796 Duplicating Services
7799 Other Business Services n.e.c. (13)

85. Educational Service Industries (some)

855 Museums and Archives
8551 Museums and Archives (14)

86. Health and Social Service Industries (several)

868 Medical and Other Health Laboratories (some)
9682 Radiological Laboratories (15)
9683 Combined Medical and Radiological Laboratories (15)

96. Amusement and Recreational Service (some)

961 Motion Picture, Audio and Video (some)
9611 Motion Picture, Audio and Video Production (16)
9613 Motion Picture Laboratories and Video Production Facilities (17)
9614 Sound Recording Services (18)

962 Motion Picture Exhibition (some)
9621 Regular Motion Picture Theatres (14)
9622 Outdoor Motion Picture Theatres (14)
9629 Other Motion Picture Exhibition (14)

963 Theatrical and Other Staged Entertainment Services (some)
9631 Entertainment Production Companies and Artists (14)
9639 Other Theatrical and Staged Entertainment Services (14)

964 Commercial Spectator Sports (some)
9641 Professional Athletes and Promoters on Own Account (14)
9643 Horse Race Tracks (14)
9644 Other Race Tracks (14)

969 Other Amusement and Recreational Services (some)
9696 Botanical and Zoological Gardens (14)

99. Other Service Industries (some)

993 Photographers
9931 Photographers

999 Other Services n.e.c. (some)
9999 Other Services n.e.c. (19)

III. AUXILIARY SERVICES THAT CAN BE SUBSTITUTED BY NEW INFORMATION TECHNOLOGY

33. Electrical and Electronic Products Industries

335 Communication and Other Electronic Equipment Industries
3359 Other Electronic and Communication Equipment (20)

57. Machinery, Equipment and Supplies Industries, Wholesale (some)

573 Industrial Machinery, Equipment and Supplies, Wholesale (some)
5731 Industrial Machinery, Equipment and Supplies, Wholesale (21)

574 Electrical and Electronic Machinery, Equipment and Supplies, Wholesale (some)
5743 Electrical Machinery, Equipment and Supplies, Wholesale (22)

579 Other Machinery, Equipment and Supplies, Wholesale (some)
5791 Office and Store Machinery, Equipment and Supplies, Wholesale (23)
5792 Service Machinery, Equipment and Supplies, Wholesale (24)
5793 Professional Machinery, Equipment and Supplies, Wholesale (25)

59. Other Products Industries, Wholesale (some)

595 Photographic Equipment and Supplies, Musical Instruments and Accessories, Wholesale
5951 Photographic Equipment and Supplies, Wholesale
5952 Musical Instruments and Accessories - Wholesale (26)

599 Other Products, n.e.c., Wholesale (some)
5991 Books, Periodicals and Newspapers, Wholesale

62. Household Furniture, Appliances and Furnishings Industries, Retail (some)

622 Household Furniture Stores
6221 Appliance, Television, Radio and Stereo Stores (27)
6222 Appliance, Television, Radio and Stereo Stores, Retail (28)
6223 Appliance, Television, Radio and Stereo Repair Shops (29)

65. Other Retail Store Industries (some)

651 Book and Stationery Stores
6511 Book and Stationery Stores

655 Musical Instruments Stores and Records Stores
6551 Musical Instruments and Records Stores
6552 Record and Tape Stores (30)

657 Camera and Photographic Supply Stores
6571 Camera and Photographic Supply Stores

659 Other Retail Stores (some)
6593 Art Galleries and Artists' Supply Stores
6599 Other Retail Stores n.e.c. (31)

77. Business Service Industries (some)

774 Advertising Services (some)
7742 Media Representatives (32)

96. Amusement and Recreational Services (some)

961 Motion Picture, Audio and Video Production and Distribution (some)
9612 Motion Picture and Video Distribution (33)
9619 Motion Picture, Audio and Video Services (34)

99. Other Service Industries (some)

991 Machinery and Equipment Rental and Leasing Services
9912 Audio-visual Equipment Rental and Leasing (35)
9913 Office Furniture and Machinery Rental and Leasing (36)
9919 Other Machinery and Equipment rental and Leasing (37)

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(1) excludes goods produced by electronic publishing.

(2) excludes equipment and parts used in recording and duplication by means of video and optic disks (CD-I, CD-V, CD-AUDIOI, CD-ROM, CD-WORM, DV-I and, eventually, erasable optic disks), as well as digital sound and video recording and duplicating equipment (used especially in the film industry and in digital audio tapes).

(3) excludes equipment related to cellular telephones and other digital communications equipment.

(4) excludes electronic parts used in the manufacture of integrated circuits and digital information processing equipment (satellites, etc.).

(5) excludes repair and checking of non-digital electronic equipment, which is included under Related Services (Technology that can be Substituted). Only material related to non-digital communications considered.

(6) includes scales, balances and cash registers not connected to a computer.

(7) includes only non-digital electronic computer instruments and equipment used in engineering, geophysics, medicine and radiography.

(8) excludes the manufacture and digital recording of sound, video disks, optic disks (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, DV-I and erasable optic disks) and digital audio tapes. Includes tapes (analog audio and video cassettes, etc.), vinyl records and musical instruments.

(9) excludes interactive cable television.

(10) includes wire and radio telegraph services and analog telephone, but excludes cellular telephone, videotex, etc.

(11) excludes digital television and music services.

(12) only non-electronic postal services considered.

(13) considers digital non-electronic services included in address and mailing list services, typing and word processing, statistical sampling, design and graphics, economic information, cataloguing, telephone solicitation and translation.

(14) only includes firms involved in cultural and spectator sports events.

(15) distinguishes laboratories using mainly non-electronic digital sensing equipment.

(16) only digital film and video production (video disks, CD-V) is excluded.

(17) excludes digital film and video processing and duplication (video disks or CD-V).

(18) excludes digital sound and image recording.

(19) considers only conference speakers, freelance editors, freelance radio and television personnel and press clipping/information agencies.

(20) considers only repair and checking of non-digital electronic equipment.

(21) considers only wholesale trade in printing and lithography equipment, supplies and machinery.

(22) excludes services related to digital information processing material and equipment such as computers, peripherals, data processing machines, digital electronic communications infrastructure, digital equipment for sound and film recording and duplication, etc.

(23) word processing machines, cash registers/point-of-sale terminals, calculators and copiers, address machines, cooking and refrigeration equipment and supplies and office and store accessories and display cases excluded.

(24) considers only film material and equipment not related to digital processing of information.

(25) digital material and equipment used in laboratories, medicine, radiography and geophysics excluded.

(26) optic disks and digital video disks excluded.

(27) excludes firms that deal mainly in retail trade in digital material and equipment for sound and film production and duplication, notably video disks, optic disks (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, DV-I and erasable optic disks) and digital audio tape.

(28) excludes firms that deal mainly in retail trade in digital material and equipment for sound and film production and duplication, notably video disks, optic disks (CD-ROM, CD-WORM, CD-AUDIO, CD-I, CD-V, DV-I and erasable optic disks) and digital audio tape.

(29) excludes repair of material and equipment considered in (26) and (27).

(30) excludes video disks, optic disks (CD-ROM, CD-WORM, CD-I, CD-V, DV-I and, eventually, erasable optic disks) and digital audio tape.

(31) only considers newsstands.

(32) representatives of digital media excluded. Includes representatives of newspapers, periodicals, radio, etc.

(33) excludes distribution or trade in digital film or video (digital video, CD-V, DV-I).

(35) rental of digital sound and audiovisual equipment and of electronic interactive cable television sets are the only exclusions.

(36) rental of electronic calculators and office furniture excluded.

(37) only the rental of photographic equipment and medical equipment for analysis and diagnosis considered.

APPENDIX D

ELECTRONIC INFORMATION PROCESSING PROFESSIONS

I. EXPERTISE IN MANUFACTURING, INSTALLING, MAINTAINING AND REPAIRING ELECTRONIC INFORMATION PROCESSING EQUIPMENT

27. University Teaching and Related Occupations

271 University Teachers and Related Occupations
- 2719 University Teaching and Related Occupations, n.e.c. (1)

279 Other Teaching and Related Occupations
- 2799 Other Teaching and Related Occupations, n.e.c. (2)

85. Product Fabricating, Assembling and Repairing Occupations (some)

851/852 Fabricating and Assembling Occupations: Metal Products, n.e.c. (some)
- 8510 Foremen/women: Fabricating and Assembling Occupations: Metal products, n.e.c. (3)
- 8525 Business and Commercial Machines Fabricating and Assembling Occupations, n.e.c. (4)
- 8526 Inspecting, Testing, Grading and Sampling Occupations: Fabricating and Assembling Metal Products, n.e.c. (5)
- 8527 Precision Instruments and Related Equipment Fabricating and Assemblng Occupations, n.e.c. (6)

853 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and related Equipment (some)
- 8530 Foremen/women: Fabricating, Assembling, Installing and Repairing Occupations; Electrical, Electronic and Related Equipment (7)
- 8534 Electronic and Related Equipment Fabricating and Assembling Occupations
- 8535 Electronic and Related Equipment Installing and Repairing Occupations, n.e.c.

8536 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment (8)
8537 Radio and Television Repairers
8538 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment (9)
8539 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and Related Equipment, n.e.c. (10)

858 Mechanics and Repairers n.e.c.
8580 Foremen/women: Mechanics and Repairers, n.e.c. (11)
8585 Business and Commercial Machine Mechanics and Repairers
8587 Watch and Clock Repairers (12)
8588 Precision instruments Mechanics and Repairers (13)
8589 Other Mechanics and Repairers, n.e.c. (14)

873 Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations (some)
8730 Foremen/women: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations (15)
8735 Wire Communications and Related Equipment Installing and Repairing Occupations
8736 Inspecting, Testing, Grading and Sampling Occupations: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations
8738 Occupations in Labouring and Other Elemental Work: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing
8739 Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations, n.e.c.

II. EXPERTISE IN OPERATING ELECTRONIC INFORMATION PROCESSING EQUIPMENT

21. Occupations in Natural Sciences, Engineering and Mathematics (some)

211 Occupations in Physical Sciences (some)
- 2117 Physical Sciences Technologies and Technicians (16)
- 2119 Occupations in Physical Sciences, n.e.c. (17)

31. Occupations in Medicine and Health (some)

315/316 Other Occupations in Medicine and Health (some)
- 3155 Radiological Technologists and Technicians
- 3156 Medical Laboratory Technologists and Technicians (18)

33. Artistic, Literary, Recreational and Related Occupations (some)

331 Occupations in Fine and Commercial Art, Photography and Related Fields (some)
- 3315 Photographers and Camera Operators

333 Occupations in Performing and Audio-visual Arts (some)
- 3332 Musicians and Singers (some) (19)

41. Clerical and Related Occupations (some)

411 Stenographic and Typing Occupations (some)
- 4110 Supervisors: Stenographic and Typing Occupations
- 4111 Secretaries and Stenographers
- 4113 Typists and Clerk-typists

414 Office Machine and Electronic Data processing Equipment Operators (some)
- 4140 Supervisors: Office Machine and Electronic Data-processing Equipment Operators
- 4141 Office Machine Operators
- 4143 Electronic Data processing Equipment Operators

417 Reception, Information, Mail and Message Distribution Occupations (some)
- 4175 Telephone Operators

4179 Reception, Information Mail and Message Distribution Occupations, n.e.c. (some) (20)

95. Other Crafts and Equipment Operating Occupations (some)

955 Electronic and Related Communications Equipment Operating Occupations, n.e.c. (some)
- 9550 Foremen/women: Electronic and Related Communications Operating Occupations, n.e.c. (some)
- 9551 Radio and Television Broadcasting Equipment Operators
- 9553 Telegraph Operators
- 9555 Sound and Video Recording and Reproduction Equipment Operators
- 9557 Motion Picture Projectionists
- 9559 Other Electronic and Related Communications Equipment Operating Occupations, n.e.c.

959 Other Crafts and Equipment Operating Occupations, n.e.c.
- 9590 Foremen/women: Other Crafts and Equipment Operating Occupations, n.e.c. (21)
- 9591 Photographic Processing Occupations
- 9599 Other Crafts and Equipment Operating Occupations, n.e.c. (22)

III. EXPERTISE IN ADAPTING ELECTRONIC INFORMATION PROCESSING TECHNOLOGY TO PHYSICAL, ORGANIZATIONAL AND HUMAN CONTEXTS

11. Managerial Administrative and Related Occupations (some)

113/114 Other Managers and Administrators (some)
- 1131 Management Occupations, Natural Sciences and Engineering (23)
- 1132 Management Occupations - Social Sciences and Related Fields (24)
- 1136 Personnel and Industrial Relations Mangement Occupations (25)
- 1147 Management Occupations, Transport and Communication Operations (26)
- 1149 Other Managers and Administrators, n.e.c. (27)

117 Occupations Related to Management and Administration (some)
1173 Organization and Methods Analysts
1174 Personnel and Related Officials (28)
1179 Occupations Related to Management and Administration, n.e.c. (29)

21. Occupations in Natural Sciences, Engineering and Mathematics (some)

211 Occupations in Physical Sciences (some)
2112 Geologists (30)
2113 Physicists (31)

214/215 Architects, Engineers and Community Planners (some)
2141 Architects (32)
2144 Electrical Engineers (33)

218 Occupations in Mathematics, Statistics, Systems Analysis and Related Fields (some)
2183 Systems Analysts, Computer Programmers and Related Occupations

23. Occupations in Social Sciences and Related Fields (some)

231 Occupations in Social Sciences (some)
2313 Sociologists, Anthropologists and Related Social Specialists (34)
2315 Psychologists (34)

235 Occupations in Library, Museum and Archival Sciences (some)
2351 Librarians, Archivists and Conservators (35)

33. Artistic, Literary, Recreational and Related Occupations (some)

333 Occupations in Performing and Audio-visual Arts (some)
3331 Conductors, Composers and Arrangers (36)

(1) only occupations involved in research, installation and operation of electronic audiovisual equipment considered.

(2) only electronic audiovisual equipment specialists and coordinators considered.

(3) only professions related to those in categories 8525, 8526 and 8527 considered.

(4) only electronic information processing equipment considered.

(5) only inspectors of photo equipment, electronic precision instruments and clocks and watches considered.

(6) only professions related to electronic information processing equipment used in photography, cameras, scientific and professional instruments, electronic calculators and peripherals and watchmaking considered.

(7) only professions related to occupations included in categories 8534 to 8539 considered.

(8) only professions specific to communications equipment and other electronic material considered.

(9) only professions specific to communications equipment and other electronic material considered.

(10) only those involved in the installation of antennas and the calibration of semi-conductors considered.

(11) only professions related to occupations included in categories 8585, 8587, 8688 and 9589 considered.

(12) only occupations related to electronic watches and clocks considered.

(13) considers only professions specific to photographic equipment, electronic scientific instruments (radiography equipment, electronic microscopes, etc.), electronic scales and electronic cameras and navigation instruments.

(14) only automatic vending machines and banking machines considered.

(15) only considers professions related to those included in categories 8735, 8736, 8738 and 8739.

(16) considers only geotechnicians and geophysics technicians, x-ray equipment operators and technicians and lab analysts and technicians working mainly with electronic microscopes and other electronic equipment.

(17) considers only prospectors and explorers and employees in physical science labs working mainly with electronic microscopes and other electronic equipment.

(18) considers only technologists and lab technicians working mainly with electronic microscopes and other electronic equipment.

(19) only musicians who play electronic instruments considered.

(20) only telephone and traffic dispatchers considered.

(21) only professions related to the occupations included in categories 9591 and 9599 considered.

(22) set designers not included.

(23) only managers of mathematics, statistics, data processing and systems analysis departments considered.

(25) only employee training personnel who use electronic information equipment considered.

(26) only managers of radio and television stations and telephone networks considered.

(27) only managers of organization and methods departments considered.

(28) only employee training personnel who use electronic information equipment considered.

(29) considers only television producers, news department heads and management consultants specialized in introduction and use of electronic equipment.

(30) only geophysicists and seismologists considered.

(31) considers only acoustics and optics experts and astrophysicists.

(32) architects in the building industry and landscape architects not included.

(33) only communications consultants, sound engineers, telephone engineers, electronic engineers and electric/electronic design engineers considered.

(34) considers only professions specialized in analyzing and evaluating the human and organizational impact of electronic equipment, and ergonomists.

(35) only CD and video library personnel, microfil archivists and consultants and experts in the field of computerized data bases, on-line reference or inter-library loans considered.

(36) only composers, arrangers and conductors of pieces performed by musicians who use electronic instruments considered.

APPENDIX E

DIGITAL ELECTRONIC INFORMATION PROCESSING PROFESSIONS

I. EXPERTISE IN MANUFACTURING, INSTALLING, MAINTAINING AND REPAIRING DIGITAL ELECTRONIC INFORMATION PROCESSING EQUIPMENT

27. University Teaching and Related Occupations

271 University Teachers and Related Occupations
- 2719 University Teaching and Related Occupations, n.e.c. (1)

279 Other Teaching and Related Occupations
- 2799 Other Teaching and Related Occupations, n.e.c. (2)

85. Product Fabricating, Assembling and Repairing Occupations (some)

851/852 Fabricating and Assembling Occupations: Metal Products, n.e.c. (some)
- 8510 Foremen/women: Fabricating and Assembling Occupations: Metal products, n.e.c. (3)
- 8525 Business and Commercial Machines Fabricating and Assembling Occupations, n.e.c. (4)
- 8526 Inspecting, Testing, Grading and Sampling Occupations: Fabricating and Assembling Metal Products, n.e.c. (5)
- 8527 Precision Instruments and Related Equipment Fabricating and Assemblng Occupations, n.e.c. (6)

853 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and related Equipment (some)
- 8530 Foremen/women: Fabricating, Assembling, Installing and Repairing Occupations; Electrical, Electronic and Related Equipment (7)
- 8534 Electronic and Related Equipment Fabricating and Assembling Occupations
- 8535 Electronic and Related Equipment Installing and Repairing Occupations, n.e.c. (8)

8536 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment (8)
8537 Radio and Television Repairers
8538 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment (9)
8539 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and Related Equipment, n.e.c. (10)

858 Mechanics and Repairers n.e.c.
8580 Foremen/women: Mechanics and Repairers, n.e.c. (11)
8585 Business and Commercial Machine Mechanics and Repairers (12)
8588 Precision instruments Mechanics and Repairers (13)
8589 Other Mechanics and Repairers, n.e.c. (14)

873 Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations (some)
8730 Foremen/women: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations (15)
8735 Wire Communications and Related Equipment Installing and Repairing Occupations (16)
8736 Inspecting, Testing, Grading and Sampling Occupations: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations (16)
8738 Occupations in Labouring and Other Elemental Work: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing (16)
8739 Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations, n.e.c. (16)

II. EXPERTISE IN OPERATING DIGITAL ELECTRONIC INFORMATION PROCESSING EQUIPMENT

21. Occupations in Natural Sciences, Engineering and Mathematics (some)

211 Occupations in Physical Sciences (some)
2117 Physical Sciences Technologists and Technicians (17)

31. Occupations in Medicine and Health (some)

315/316 Other Occupations in Medicine and Health (some)
3155 Radiological Technologists and Technicians

33. Artistic, Literary, Recreational and Related Occupations (some)

331 Occupations in Fine and Commercial Art, Photography and Related Fields (some)
3315 Photographers and Camera Operators (18)

41. Clerical and Related Occupations (some)

414 Office Machine and Electronic Data processing Equipment Operators (some)
4140 Supervisors: Office Machine and Electronic Data-processing Equipment Operators (19)
4143 Electronic Data processing Equipment Operators

95. Other Crafts and Equipment Operating Occupations (some)

955 Electronic and Related Communications Equipment Operating Occupations, n.e.c. (some)
9550 Foremen/women: Electronic and Related Communications Operating Occupations, n.e.c. (some) (20)
9551 Radio and Television Broadcasting Equipment Operators (21)
9555 Sound and Video Recording and Reproduction Equipment Operators (21)
9559 Other Electronic and Related Communications Equipment Operating Occupations, n.e.c. (21)

III. EXPERTISE IN ADAPTING DIGITAL ELECTRONIC INFORMATION PROCESSING TECHNOLOGY TO PHYSICAL, ORGANIZATIONAL AND HUMAN CONTEXTS

11. Managerial Administrative and Related Occupations (some)

113/114 Other Managers and Administrators (some)
- 1131 Management Occupations, Natural Sciences and Engineering (22)
- 1132 Management Occupations - Social Sciences and Related Fields (23)
- 1136 Personnel and Industrial Relations Mangement Occupations (24)
- 1147 Management Occupations, Transport and Communication Operations (25)
- 1149 Other Managers and Administrators, n.e.c. (26)

117 Occupations Related to Management and Administration (some)
- 1173 Organization and Methods Analysts
- 1174 Personnel and Related Officials (27)
- 1179 Occupations Related to Management and Administration, n.e.c. (28)

21. Occupations in Natural Sciences, Engineering and Mathematics (some)

211 Occupations in Physical Sciences (some)
- 2112 Geologists (29)
- 2113 Physicists (30)

214/215 Architects, Engineers and Community Planners (some)
- 2141 Architects (31)
- 2144 Electrical Engineers (32)

218 Occupations in Mathematics, Statistics, Systems Analysis and Related Fields (some)
- 2183 Systems Analysts, Computer Programmers and Related Occupations

23. Occupations in Social Sciences and Related Fields (some)

231 Occupations in Social Sciences (some)
2313 Sociologists, Anthropologists and Related Social Specialists
2315 Psychologists (33)

235 Occupations in Library, Museum and Archival Sciences (some)
2351 Librarians, Archivists and Conservators (34)

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(1) only occupations involved in research, installation and operation of digital audiovisual equipment considered.

(2) only digital audiovisual equipment specialists and co-ordinators considered.

(3) only professions related to those in categories 8525, 8526 and 8527 considered.

(4) only digital information processing equipment considered.

(5) only inspectors of digital scientific and professional instruments considered.

(6) only professions related to digital information processing equipment used in cameras, scientific and professional instruments, electronic calculators and peripherals considered.

(7) only professions related to occupations included in categories 8534 to 8536, 8538 and 8539 considered.

(8) only professions specific to communications equipment and other digital equipment considered.

(9) only professions specific to communications equipment and other electronic material considered.

(10) only those involved in the installation of antennas and the calibration of semi-conductors considered.

(11) only professions related to occupations included in categories 8585, 8588 and 8589 considered.

(12) only occupations related to digital office machines and data processing equipment considered.

(13) considers only professions specific to electronic scientific instruments (radiography equipment, etc.), digital cameras and navigation instruments.

(14) only banking machines considered.

(15) only considers professions related to those included in categories 8735, 8736, 8738 and 8739.

(16) considers only professions related to fiber optics communications.

(17) considers only X-ray technicians using digital equipment such as that used in tomography and computer-assisted resonance spectroscopy.

(18) photographers and operators of analog cameras not considered.

(19) only professions related to those listed in category 4143 considered.

(20) considers only professions related to those listed in categories 9551, 9555 and 9559.

(21) includes only engineers and operators in television and telecommunications, and digital video and sound recording and duplicating equipment.

(22) considers only managers of mathematics, statistics, data processing and systems analysis departments.

(23) only head librarians and managers of CD, video and record libraries and microfilm archives considered.

(24) only employee training persoinnel who use digital equipment considered.

(25) only managers of digital telephone networks considered.

(26) only managers of organization and methods departments considered.

(27) only employee training personnel who use digital information equipment considered.

(28) considers only television producers, news department heads and management consultants specialized in introduction and use of electronic equipment.

(29) only geophysicists and seismologists considered.

(30) considers only acoustics and optics experts and astrophysicists.

(31) only architects specialized in office automation installation included.

(32) only digital communications consultants, sound engineers, digital telephone engineers, electronic engineers and electronic design engineers considered.

(33) considers only professions specialized in analyzing and evaluating the human and organizational impact of digital equipment, and ergonomists.

(34) only CD and video library personnel, microfil archivists and consultants and experts in the field of computerized data bases, on-line reference or inter-library loans considered.

APPENDIX F

PROFESSIONS RELATED TO INFORMATION PROCESSING PRODUCTS THAT CAN BE SUBSTITUTED BY NEW TECHNOLOGY

I. EXPERTISE IN MANUFACTURING, INSTALLING, MAINTAINING AND REPAIRING INFORMATION PROCESSING EQUIPMENT THAT CAN BE SUBSTITUTED

27. University Teaching and Related Occupations

271 University Teachers and Related Occupations
- 2719 University Teaching and Related Occupations, n.e.c. (1)

279 Other Teaching and Related Occupations
- 2799 Other Teaching and Related Occupations, n.e.c. (2)

85. Product Fabricating, Assembling and Repairing Occupations (some)

851/852 Fabricating and Assembling Occupations: Metal Products, n.e.c. (some)
- 8510 Foremen/women: Fabricating and Assembling Occupations: Metal products, n.e.c. (3)
- 8523 Industrial, Farm, Construction and Other Mechanized Equipment and Machinery Fabricating and Assembling Occupations, n.e.c. (4)
- 8525 Business and Commercial Machines Fabricating and Assembling Occupations, n.e.c. (5)
- 8526 Inspecting, Testing, Grading and Sampling Occupations: Fabricating and Assembling Metal Products, n.e.c. (6)
- 8527 Precision Instruments and Related Equipment Fabricating and Assembling Occupations, n.e.c. (7)

853 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and related Equipment (some)
- 8530 Foremen/women: Fabricating, Assembling, Installing and Repairing Occupations; Electrical, Electronic and Related Equipment (8)
- 8534 Electronic and Related Equipment Fabricating and Assembling Occupations (9)

8535 Electronic and Related Equipment Installing and Repairing Occupations, n.e.c. (10)
8537 Radio and Television Repairers

858 Mechanics and Repairers n.e.c.
8580 Foremen/women: Mechanics and Repairers, n.e.c. (11)

8584 Industrial, Farm and Construction Machinery Mechanics and Repairers (12)
8585 Business and Commercial Machine Mechanics and Repairers (13)
8588 Precision instruments Mechanics and Repairers (14)

II. EXPERTISE IN AREAS THAT MIGHT BE COMPLETELY OR PARTIALLY SUBSTITUTED BY NEW DIGITAL ELECTRONIC PRODUCTS

21. Occupations in Natural Sciences, Engineering and Mathematics (some)

211 Occupations in Physical Sciences (some)
2117 Physical Sciences Technologists and Technicians (15)
2119 Occupations in Physical Sciences, n.e.c. (16)

216 Other Occupations in Architecture and Engineering (some)
2160 Supervisors: Other Occupations in Architecture and Engineering (17)
2163 Draughting Occupations

23. Occupations in Social Sciences and Related Fields (some)

235 Occupations in Library, Museum and Archival Sciences (some)
2353 Technicians in Library, Museum and Archival Sciences

31. Occupations in Medicine and Health (some)

315/316 Other Occupations in Medicine and Health (some)
3155 Radiological Technologists and Technicians (18)
3156 Medical Laboratory Technologists and Technicians (18)

33. Artistic, Literary, Recreational and Related Occupations (some)

331 Occupations in Fine and Commercial Art, Photography and Related Fields (some)
- 3311 Painters, Sculptors and Related Artists
- 3313 Product and Interior Designers
- 3114 Advertising and Illustrating Artists
- 3315 Photographers and Camera Operators (19)
- 3319 Occupations in Fine and Commercial Art, Photography and Related Fields, n.e.c.

333 Occupations in Performing and Audio-visual Arts (some)
- 3332 Musicians and Singers (some) (20)

41. Clerical and Related Occupations (some)

411 Stenographic and Typing Occupations (some)
- 4110 Supervisors: Stenographic and Typing Occupations
- 4111 Secretaries and Stenographers
- 4113 Typists and Clerk-typists

413 Bookkeeping, Account-recording and Related Occupations
- 4130 Supervisors: Bookkeeping, Account-recording and Related
- 4131 Bookkeepers and Accounting Clerks
- 4133 Cashiers and Tellers
- 4135 Insurance, Bank and Other Finance Clerks
- 4137 Statistical Clerks
- 4139 Bookkeeping, Account-recording and Related Occupation, n.e.c.

414 Office Machine and Electronic Data processing Equipment Operators (some)
- 4140 Supervisors: Office Machine and Electronic Data-processing Equipment Operators
- 4143 Electronic Data processing Equipment Operators

415 Materials Recording, Scheduling and Distributing Occupations (some)
- 4150 Supervisors: Material Recording, Scheduling and Distributing Occupations (21)
- 4151 Production Clerks (22)
- 4155 Stock Clerks and Related Occupations (22)
- 4159 Material Recording, Scheduling and Distributing Occupations, n.e.c (22)

416 Library, File and Correspondence Clerks and Related Occupations
- 4160 Supervisors: Library, File and Correspondence Clerks and Related Occupations
- 4161 Library and File Clerks
- 4169 Library, File and Correspondance Clerks and Related Occupations, n.e.c.

417 Reception, Information, Mail and Message Distribution Occupations (some)
- 4170 Supervisors: Reception, Information, Mail and Message Distribution Occupations
- 4171 Receptionists and Information Clerks
- 4172 Mail Carriers
- 4173 Mail and Postal Clerks
- 4175 Telephone Operators
- 4177 Messengers
- 4179 Reception, Information, Mail and Message Distribution Occupations, n.e.c. (some) (20)

419 Other Clerical and Related Occupations
- 4190 Supervisors: Other Clerical and Related Occupations
- 4191 Collectors
- 4192 Claim Adjusters
- 4193 Travel Clerks, Ticket, Station and Freight Agents
- 4194 Hotel Clerks
- 4195 Personnel Clerks
- 4197 General Office Clerks
- 4199 Other Clerical and Related Occupations, n.e.c.

51. Sales Occupations (some)

513/514 Sales Occupations, Commodities (some)
- 5131 Technical Sales Occupatins and Related Advisers
- 5133 Commercial Travellers
- 5141 Street Vendors and Door-to-door Sales Occupations
- 5143 Newspaper Carriers and Vendors

517 Sales Occupations, Services (some)
- 5171 Insurance Sales Occupations
- 5172 Real Estate Sales Occupations
- 5173 Sales Agents and Traders, Securities
- 5174 Advertising Sales Occupations
- 5177 Business Services Sales Occupations
- 5179 Sales Occupations: Services, n.e.c.

519 Other Sales Occupations (some)
5191 Buyers, Wholesale and Retail Trade
5199 Other Sales Occupations, n.e.c.

61. Service Occupations (some)

614 Personal Service Occupation (some)
6144 Guides
6149 Personal Service Occupations, n.e.c. (23)

95. Other Crafts and Equipment Operating Occupations (some)

951 Printing and Related Occupations
9510 Foremen/women: Printing and Related Occupations
9511 Typesetting and Composing Occupations
9512 Printing Press Occuaptions
9513 Stereotyping and Electrotyping Occupations
9514 Printing Engraving, Except Photoengraving Occupations
9515 Photoengraving and Related Occupations
9517 Bookbinding and Related Occupations
9518 Occupations in Labouring and Other Elemental Work: Printing and Related Activities
9519 Printing and Related Occupations, n.e.c.

955 Electronic and Related Communications Equipment Operating Occupations, n.e.c. (some)
9550 Foremen/women: Electronic and Related Communications Operating Occupations, n.e.c. (24)
9551 Radio and Television Broadcasting Equipment Operators (25)
9553 Telegraph Operators
9557 Motion Picture Projectionists
9559 Other Electronic and Related Communications Equipment Operating Occupations, n.e.c. (26)

959 Other Crafts and Equipment Operating Occupations, n.e.c.
9590 Foremen/women: Other Crafts and Equipment Operating Occupations, n.e.c. (27)
9591 Photographic Processing Occupations
9599 Other Crafts and Equipment Operating Occupations, n.e.c. (28)

(1) only occupations involved in research, installation and operation of non-digital audiovisual equipment considered.

(2) only non-digital audiovisual equipment specialists and coordinators considered.

(3) only professions related to those in categories 8523, 8525, 8526 and 8527 considered.

(4) only occupations involved in printing equipment manufacture or assembly considered.

(5) only occupations involved in manufacturing non-digital equipment considered.

(6) only inspectors of non-digital scientific and professional instruments considered.

(7) only professions related to non-digital equipment used in scientific and professional instruments considered.

(8) only professions related to occupations included in categories 8534, 8535 and 8537 considered.

(9) occupations related to reaio and television sets not considered.

(10) only radio and television technicians considered.

(11) only professions related to occupations included in categories 8584, 8585 and 8588 considered.

(12) only printing machine mechanics considered.

(13) considers only mechanics and repairmen for non-digital office machines and data processing equipment.

(14) only mechanics and repairmen of non-digital precision instruments considered.

(15) considers only X-ray technicians not using digital equipment such as that used in tomography and computer-assisted resonance spectroscopy.

(16) only explorers and prospectors considered.

(17) only professions related to those listed in category 2163 considered.

(18) considers only technologists and lab technicians not working in the field of tomography and computer-assisted resonance spectroscopy.

(19) only occupations related to photography considered.

(20) only musicians considered.

(21) only professions related to the supervision of occupations listed in categories 4155 and 4159 considered.

(22) considers only occupations involved in taking inventory, purchasing and control.

(23) only ushers included.

(24) considers only professions related to those retained in categories 9551, 9553, 9557 and 9559.

(25) Operators and engineers in television, telecommunications and digital video and sound recording and duplication not included.

(26) includes boom and radio, broadcast (radio and phototelegraph) operators.

(27) only includes professions related to occupations listed in categories 9591 and 9599.

(28) does not include set designers.